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CONTENTS

<i>The Privileges and Responsibilities of the Chemical Analyst</i> : PROFESSOR H. P. TALBOT	397
<i>The Crocker Land Expedition of the American Museum of Natural History</i>	404
<i>George Jervis Brush</i> : PROFESSOR WILLIAM E. FORD	409
<i>The Rainey African Expedition</i>	411
<i>The Pacific Association of Scientific Societies</i>	412
<i>Scientific Notes and News</i>	412
<i>University and Educational News</i>	415
<i>Discussion and Correspondence</i> :—	
<i>The Corn Snake in New Jersey</i> : WM. T. DAVIS. <i>Fundulus and Fresh Water</i> : JOHN MURDOCK	416
<i>Scientific Books</i> :—	
<i>Pütter's Vergleichende Physiologie</i> : PROFESSOR FREDERIC S. LEE. <i>Olcott on Star Lore of All Ages</i> : PROFESSOR CHARLES LANE POOR	417
<i>Scientific Journals and Articles</i>	419
<i>The Present Known Distribution of the Chestnut Bark Disease</i> : HAVEN METCALF	421
<i>Special Articles</i> :—	
<i>Senility in Meristematic Tissue</i> : PROFESSOR H. M. BENEDICT	421
<i>The Washington Meeting of the American Chemical Society</i> : PROFESSOR CHARLES L. PARSONS	422
<i>Societies and Academies</i> :—	
<i>The Chicago Section of the American Mathematical Society</i> : PROFESSOR H. E. SLAUGHT. <i>The Botanical Society of Washington</i> : DR. W. W. STOCKBERGER	435

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THE PRIVILEGES AND RESPONSIBILITIES OF THE CHEMICAL ANALYST¹

IN his presidential address on "The Dignity of Analytical Work," delivered before the American Chemical Society in 1897, Dr. Charles B. Dudley directed attention to the claims which may be asserted in behalf of analytical chemistry as an important and dignified branch of chemical science, and the necessity for intelligent, careful work on the part of even the routine analyst. From a somewhat different standpoint, Dr. W. F. Hillebrand, of international reputation as an analyst, presented at the Philadelphia meeting of the Society, in 1904, a critical review entitled "Some Thoughts on the Present Conditions of Analytical Chemistry," which was based upon his experience as chairman of committees intrusted with the formulation of standard methods of analysis and the investigation of the causes for the remarkable variation in the results of different analysts examining a given sample of material. He sounded a definite and clear note of warning with respect to the prevalence of a lack of care and intelligence, and ascribed the conditions, in part at least, to faulty training in our educational institutions. Within the past month there has appeared an interesting brochure from the pen of Dr. Wilhelm Böttger, professor at the University of Leipzig, entitled "Der Stand und Wege der Analytischen Chemie," in which he criticizes the too empirical nature of much of the analytical

¹ Read at a joint session of the American Chemical Society and Section C of the American Association for the Advancement of Science at Washington, December 27, 1911.

practise of the day and makes valuable suggestions respecting the way out of these conditions.

Dr. Dudley's plea was authoritative and convincing, and attracted much interest when it was made public. Dr. Hillebrand spoke from a fullness of experience and with an earnestness which made his criticism strike home. Dr. Böttger writes from the viewpoint of one who is at home in the analytical field and has also thoroughly familiarized himself with the advances of chemical science in other lines which are closely related to the work of the analyst. Is there, then, an excuse for a fresh homily on the status of analytical chemistry? May I say frankly that, had the pamphlet from Dr. Böttger reached me before the title of this address had been announced and its general outline prepared, I should have been inclined to answer this query in the negative, and may I confess that, since Dr. Böttger can write with greater authority than I on certain phases of the present situation, I shall quote freely from him.

But, on the other hand, it is probable that not many of you have recently read the addresses referred to above, a thing to be strongly recommended at your next opportunity, and it is certainly true that too many of the chemical analysts (not alone the "analytical chemists" in a professional sense) are not putting out a grade of work which is commendable to them. It is not unreasonable, then, that we should take time to survey the field; nor is it true that such a survey will show no signs of improvement from which we may take comfort and courage.

When we consider the relation of analytical chemistry to the other branches of our science, we still face such questions as these: Why is it that analytical chemistry lags behind other branches of chemistry in its scientific development? Why is it that

our journals are so often filled with "new" processes of alleged reliability and usefulness, which never acquire general recognition and which are frequently condemned as worthless by those who attempt to apply or repeat them? Why is it that reports of commission after commission on "standard" methods are published, only to sink into oblivion without awakening any interest or attaining any useful purpose? Why is it that the chemical analysts, as a class, lack the respect which should be commanded by those who are following a profession and practising an art which, in its best estate, calls for a very high degree of intelligence, as well as manual skill? Why is it that chemical analyses have come to be made at prices worse than those of the bargain counter? These are, it appears, all pertinent questions to-day.

It has been frequently pointed out that analytical chemistry has so long been regarded as the servant of the chemist—referred to by Ostwald as the "hand-maiden" of chemistry—that far too much attention has been directed to obtaining large returns for small wages. We have nearly forgotten that this "hand-maiden" herself has a natural comeliness, and have ignored the fact that even a little more encouragement to her to improve her methods and accomplish her tasks more thoroughly would easily fit her to sit at the family table—a privilege, formerly hers, of which she has long been deprived. It is easy to see, as Dr. Böttger points out anew, how, after the days of Liebig, the relegation of analytical chemistry to a subordinate position came about amid the interest attaching, first, to rapid developments in organic chemistry, and later to those in physical chemistry, and especially through its connection with the phenomenal growth of the industries, which demanded "results" and too often have allowed what appeared to

be "good enough" for a temporary purpose to become a permanent standard of attainment. These latter conditions must, however, always be reckoned with, and it is not my purpose to spend time in deploring them, or in regretting the conditions of the past, but to ask what encouragement may be offered to the analyst of to-day and what the outlook is for the future.

My chief criticism of the situation in the recent past would be this: That the chemical analysts, as a class, have failed to take advantage of their opportunities, and that those intrusted with their training are considerably responsible for this situation. Specifically, I mean that too many practising analysts allow themselves to remain in ignorance of the aids to accurate, intelligent work which that branch of chemistry known as physical chemistry, in a broad sense, has contributed, and that, while our students are usually made familiar at some time with much of this material, it is not coordinated with their training as analysts. We train too much for manipulative skill and analytical facility and do not sufficiently educate toward that critical intelligence which enables a man to test his own work, to view it from the outside, as it were, and will not allow him to regard it as satisfactory until he has not only assured himself with respect to such matters as the purity of his reagents or the stability of his glassware, but has also studied the effect of a variation of individual factors and of the chemical conditions, so far as his time will permit. Obviously, a practising analyst can rarely afford the time to make his methods of analysis the subject of exhaustive investigations, but something far less than this, yet considerably more than is too often done, would have prevented many deplorable happenings, including the publication of many unreliable analytical procedures to the be-

wilderment of the entire chemical fraternity.

That the analyst who is ambitious to make the most of his privileges to-day is in a position to obtain a larger measure of aid and comfort than formerly is indicated by an instance cited by Dr. Böttger. He contrasts the work of Professor Clemens Winkler upon the atomic weight of nickel with the later work of Professor J. W. Richards, which showed the figure obtained by Winkler to be in error by 0.3 per cent. Winkler was highly skilled in the technique required for the work which he undertook, and possessed special mental aptitude for the task, as Richards himself has testified. It appears, then, reasonable to conclude that Richards, although similarly equipped, succeeded in attaining greater accuracy than Winkler rather because of his greater ability to recognize those factors which would lead to error than because of greater ability to overcome the difficulties after they had been recognized. Richards had at his command a qualitative and, in some cases, a quantitative knowledge of phenomena, unrecognized until recently, which permitted not only the detection of new sources of inaccuracy, but often enabled him to estimate the extent of the errors involved. He made the knowledge of the day serve his keen intellect to its utmost. He took advantage of his privileges.

But perhaps some of you will say, "This is atomic weight work, not analytical chemistry. Those men are ripe scholars and investigators who can command a knowledge of the advances of their science. All this has little to do with me, a busy analyst, or an unripe scholar." That, however, is just where the issue really lies, and it is because so many have thought and still think that a great deal of the accumulated chemical knowledge in the field of general or physical chemistry is "beyond them"

and is something reserved for the use of those with chemical leisure on their hands, that our progress toward better things is so slow. It is also the reason why a great deal of time is wasted on procedures which are almost without value as soon as any one of the particular conditions (often very far from practical conditions) under which they were tested, is altered. It is not at all a difficult matter to obtain an understanding of at least the meaning, for example, of chemical equilibrium and the laws which apparently underlie equilibrium phenomena; yet there are instances of the publication of processes recommending procedures in defiance of these principles, and a great deal of time is wasted in private because of ignorance of them. An interesting and fruitful application of these principles is to be found in connection with the processes of neutralization and hydrolysis, and in selection of suitable indicators for use with acids and bases of varying strength. Modern research has changed this from a haphazard procedure to one of comparative exactness. The principles are not difficult to follow and, if once mastered, can not fail to render any subsequent work in this field more intelligent and, therefore, more pleasurable.

The phenomena of adsorption, with their attendant annoyances to the analyst, have been widely studied. The results are perhaps less positively helpful than in the case of the indicators, but the material is nevertheless well worth attention and study. Colloids—which probably play an often unsuspected part in our analyses for good or ill—must not be overlooked by the well-informed chemist who would best economize his time and energies, and the simple matter of the best way to wash a filter and its contents, long ago pointed out by Ostwald, are not as familiar as they should be. The spectroscope and micro-

scope are more useful than formerly, a system of micro-analysis, both qualitative and quantitative, having been developed with the latter instrument; the ultramicroscope may well open up new lines of study with respect to the formation of precipitates, the existence of colloids or the conditions controlling electrolytic deposition; wash-waters may now sometimes be advantageously tested through their electrical conductivity; the refractometer, the nephelometer, the colorimeter, the centrifuge, are all finding extended usefulness, and it is incumbent upon the analyst to understand these instruments, and their underlying principles thoroughly if he is to fully avail himself of their aid.

It is probable that analytical chemistry has been as directly aided by the increased accuracy of solubility determinations as in any other way; and these have largely been made practicable by the development of the physico-chemical methods of measurement. These determinations have made it possible to judge of the greatest attainable accuracy of a precipitation method, and have also made practicable the use of a correction factor in the case of unavoidable losses. The analyst should no longer content himself with the mere thought that such losses are inevitable until he has definite assurance that data sufficient to permit of a reasonably accurate estimation of these losses are not to be found. The values obtained for the solubilities of the various sulphides, which are much more accurate than those formerly available, have alone done a great deal to enable the working out of a more reliable scheme of qualitative detection of the elements, one which is based on scientific deductions, confirmed by careful experimentation, as, for example, in the separation of the sulphides of arsenic, antimony and tin by hydrochloric acid, the separation of zinc from the metals of the

copper group, the complete precipitation of lead and cadmium as sulphides.

It is so much a matter of common knowledge that the chemical changes upon which analytical procedures rest are far better understood, and therefore controlled, because of the fruitful hypothesis of Arrhenius, that no extended statement of this seems necessary in this connection. It may, however, be wise to point out that there is a certain tendency to assume that this theory and its applications constitute "physical chemistry" and that there is reason for complacency when one has acquired a fair understanding of these points. While the foregoing statements are far from complete with respect to those points at which our modern chemistry and physics touch analytical chemistry, it must be evident that the possibilities for assistance are far wider and, indeed, more important than a mere ionic interpretation of chemical changes. For it must be admitted that our knowledge of ionic changes, even in a qualitative sense, is still inexact with reference to many reactions familiar to the analyst, and that the most useful data are those of a quantitative character, to obtain which we must command a knowledge of the wider field of physical chemistry in a broad sense.

Modern investigation has then, especially in the border land between physics and chemistry, given us new tools for our trade as chemical analysts. But it has done still more for us by showing us what it means to use them, and it is here that, as analysts, we should learn our lesson. It is, I think, fair to say that the one fundamental reason why much of the published work of individuals or commissions fails of effectiveness and permanence and, in part, the reason for the lack of respect in which the chemical analyst and his work are held, is the lack of appreciation on the part of

authors of the one-sidedness of the published results, and of the procedures adopted as adequate or as the best obtainable. The pages of our journals are, unfortunately, too largely occupied by descriptions of processes, which are supported by data obtained under but one set of conditions, and applied at most to one or two sorts of materials. These conditions are empirically established and are, in many cases, not such as could be controlled under the necessary routine of analysis of materials of more complex structure. The tests, upon which efficiency is claimed, have often been made with pure materials, and in solutions, the contents of which could be easily adjusted and determined, contrasting in this respect with customary analytical conditions. Many authors of analytical procedures lose sight of the important fact that the success of these procedures, in their own hands, has usually been attained only at the cost of considerable practise and as the result of the observance of a series of, often, apparently minor modifications, which they more or less unconsciously ignore when they describe the process for publication. It is exactly this really inexcusable ignoring of these conditions, on the one hand, and the even more frequent failure to study their influence systematically, on the other hand, which has condemned much of the published material. It is true that the intelligent author is between two fires—on the one hand his desire to help his colleagues, on the other hand, the board of editors who, in these days of many papers, must insist upon reasonable brevity. As one who has seen many manuscripts in this field, may I suggest, especially to the younger authors, that I am sure that, while the editors must insist on the omission, for example, of statements to the effect that it is inadvisable to remove a stirring rod

from a quantitative solution without washing it, and, while they must advise the elimination of tabulated statements of the failures encountered on the road to success, and must, in general, curb a rather natural desire to send a four-page reprint containing two-pages worth of work to one's friends, they will welcome an increased exactness of statement of the controlling conditions of analyses, especially when it appears that these factors have been intelligently studied.

It is too obvious to really need mention, that not all of the published work is faulty, and it is notably true that some of the more recent work is of exceptionally high character and sets an excellent standard toward which analysts in general should strive. Reference will be made to only two well-known publications—those of Noyes, Bray and their associates on the development of a scheme of qualitative analysis on a scientific and exact basis, and the work of Allen, Johnston and Adams on the determination of sulphur as barium sulphate. In both these there has been a systematic study of sources of error and, where apparently unavoidable errors appear, the possibility of correction for them has been carefully investigated as well as the determination of the special conditions under which these errors could be reduced to a minimum. Dr. Bray has stated to me (and this view is confirmed by Dr. Böttger) that possibly the greatest service of physical chemistry is the impetus which the precise methods which have been worked out have given to the more critical study of the sources of error and to their prevention or correction. This, in their opinion, is a greater service than any other single attainment in itself.

It may be admitted that few employed as analysts can hope to obtain so complete an insight into other fields as is possessed

by Noyes, Bray, Böttger or Johnston, and their immediate coworkers. But it is not unreasonable to point out that a much less thorough knowledge would be of enormous assistance and would lead to the prevention of another fault in the point of view of most analysts; namely, the overlooking of the element of compensation of errors in their work. Few things would do more to bring up the character of analytical work than a better appreciation of the fallacies involved in "check analyses" or the false sense of confidence in an approximate summation to one hundred per cent. Just here, I believe, our teachers are often at fault. Every student tends to glorify his "check analyses," too often even to the destruction of his professional integrity. Even when there is no question of honesty involved, there is a blind faith in their infallibility, and this is reflected in much of the published work. The idea that two analyses carried out with practically identical weights of sample and equal quantities of reagents may "agree," but be perfectly worthless because of inherent errors, never really seems to penetrate the mind of many men. The fact that so simple a thing as variation in the quantities taken for analysis is a wise precaution in testing a process is also unperceived. I do not mean to say that most, or possibly all, teachers do not point out these matters, but I do mean to say that many students never get a clear perception of them, and still less of the idea that dependence upon compensation of errors in an analytical procedure is quite insecure unless the factors governing the occurrence of these errors are approximately known. I feel sure that these defects in our teaching would be lessened if we were, in general, to pay less attention to teaching a variety of methods, as such, and more to the careful investigation of a

few, on a scale commensurate with even the limited knowledge which a junior or senior really possesses. This should be done with the purpose of enabling him to criticize his own work, to study it for possible errors, their causes, and, so far as practicable, their amounts. He may then be encouraged to criticize the published work of others, for which, by the way, no end of useful material is at hand. In this connection, it may not be out of place to recommend to chemical analysts, teachers and practitioners an annual perusal of Dr. Hillebrand's address referred to above, in which he deals with the shortcomings of analysts with respect to reagents and manipulative methods, which it has not seemed necessary to attempt to touch upon here.

Finally, just a word regarding the status of the analytical chemist, using this term to denote one with whom analytical chemistry is essentially a vocation. There is, I think, no doubt that this is distinctly unsatisfactory. In the minds of the general public, to be sure, a chemist is essentially an analyst but, in the minds of employers, an analyst is too often an inferior grade of chemist who can be readily displaced by a reasonably intelligent boy, and whom boy's wages should satisfy. Our young men who have been chemically educated almost universally begin their professional careers in the technical field in our analytical laboratory. While we wisely admonish them to fulfil the task at hand in such a way as to earn more than they receive, to more than "make good," in the phrase of the day, we also urge them not to be content with such positions as will permanently restrict them to analytical service. This, too, under existing conditions, is no doubt wise. But it would seem that the time has come when employers should recognize that work entrusted to

boys who, while possibly capable of carrying out routine operations, have no ability to deal with any of the inevitable complications arising from exceptional conditions, or work entrusted even to men who are underpaid and without the encouragement of future adequate recognition, is likely to lack the requisite quality for the attainment of the best possible results. It may not be practicable to create permanently attractive positions for a large number of strong men, but there should be more of these men in the works laboratory than are now found there. Moreover, while a works laboratory is confessedly not a savory neighbor, the chemists should courageously demand that they should not be relegated to some ill-lighted, half-ventilated and dirty corner, as is too often done. This does not mean that quartered-oak desks, glass shelves or expensive trimmings should be asked for, but merely such quarters as will permit self-respecting men, who take pride in their work, to operate under conditions which permit them to render their best service. Some may say that this is an easy suggestion to make on the part of one not immediately associated with the stress of industrial conditions, but one which it is difficult to carry out. This is frankly admitted, but the belief persists that the analytical chemists owe it to themselves to make an effort to secure for themselves and their work a larger measure of recognition such as this suggestion would involve.

If we consider the current prices for chemical analyses, one is prone to think that in one field, at least, competition has had full play. It were, of course, rank heresy in this good city to suggest restraint, and yet it seems full time that something should be done, lest the day might come when the chemist would have to pay the manufacturer for the privilege of ma-

king analyses for him. How can an analytical chemist hope to maintain his professional standing when his charges for individual analyses—even when done in quantity—are such that, unless he is to count his own time as without value (and sometimes even under such an assumption), he can not possibly do reliable work without an actual financial loss? I do not wish to draw any unpleasant or unfair inferences as to which horn of such a dilemma the commercial analytical chemists choose; for the most of them are, no doubt, trying to make the best of a difficult situation. Unfortunately, I have no specific remedy to propose, but it is all too evident that these conditions tend to belittle this branch of our science, to result in a large output of inferior work, and to create a distrust which spreads unduly. It behooves us all to at least do what we can to bring home to those who are to place dependence upon work done at these ruinous prices that, in many instances, they are getting just about what they pay for and no more, and that the service is not such as they owe it to themselves to make possible by more adequate remuneration.

Whether we consider present analytical practise from the view of the scientist or as a vocation, we find much that calls for improvement. What the present situation imperatively demands, then, is a courageous and frank admission that the quality of much of the analytical work, practised or published, is inferior to what might reasonably be attained because much of it is one-sided and ill-considered from a scientific standpoint. Let there be a realization that, while no amount of theorizing can take the place of skilful and accurate work, or of a certain amount of empirical experimentation, the analysts should cease pulling on their own boot-straps and avail

themselves more generally of the aids from other portions of our science to help to lift themselves and their art to the worthy position to which both are entitled. Let the chemical analysts realize that they must take greater pride in their work for its own sake, let them demand a recognition of the dignity claimed for it by Dr. Dudley, and let them give to it the best that is in them, in both activity of mind and skill of hand. This is a duty which is owed to our national reputation, to chemical science, pure and applied, and to our own welfare.

H. P. TALBOT

MASSACHUSETTS INSTITUTE
OF TECHNOLOGY

*THE CROCKER LAND EXPEDITION UNDER
THE AUSPICES OF THE AMERICAN
MUSEUM OF NATURAL HISTORY
AND THE AMERICAN GEO-
GRAPHICAL SOCIETY*

THE existence or non-existence of land northwest of Grant Land and the configuration of the polar continental shelf of North America seem to be two of the greatest of the geographical problems still unsolved. There is, in addition, much important geological, geographical, zoological and other scientific work to be done in certain parts of the Arctic regions. Two thoroughly qualified young men have volunteered their services as leaders of an expedition to attack the problems and do the work. Under this combination of circumstances and with the proviso that sufficient funds be provided from outside sources, the American Museum of Natural History and the American Geographical Society have made liberal appropriations in support of the enterprise, and the former institution has taken over its organization and management, feeling that it is well worthy of the backing of the scientific institutions of the country.

The leaders of the expedition are to be George Borup (A.B., Yale, 1907), assistant curator of geology in the American Museum

of Natural History, and Donald B. MacMillan (A.B., 1898; A.M. (Hon.), 1910, Bowdoin). They have become well known to the public, scientific as well as general, through their work under Admiral Peary on his last polar expedition, through Mr. Borup's book, "A Tenderfoot with Peary," and his lectures and through Mr. MacMillan's extensive lecturing throughout the country. They have received Peary's unqualified indorsement for the work in hand. Mr. Borup has been devoting his whole attention during the past two and a half years to studies in the field and at Yale to fit himself thoroughly for scientific geological and geographical exploration. He is a fellow of the Royal Geographical Society (of London) and a member of the New York Academy of Sciences. Mr. MacMillan, since his return from the Peary expedition, has been studying ethnology and practical astronomy at Harvard. In the summer of 1910, he was a member of the Cabot party which was the first to cross central Labrador from the sea to George River, and he spent the summer of 1911 cruising along the coast of Labrador in an eighteen-foot open canoe, studying the Eskimo from Hopedale to Killinek (60° N. Lat.). Mr. MacMillan is a member of the American Geographical Society and the Appalachian Mountain Club.

The object and work of the expedition may, perhaps, be best stated in Mr. Borup's own words:

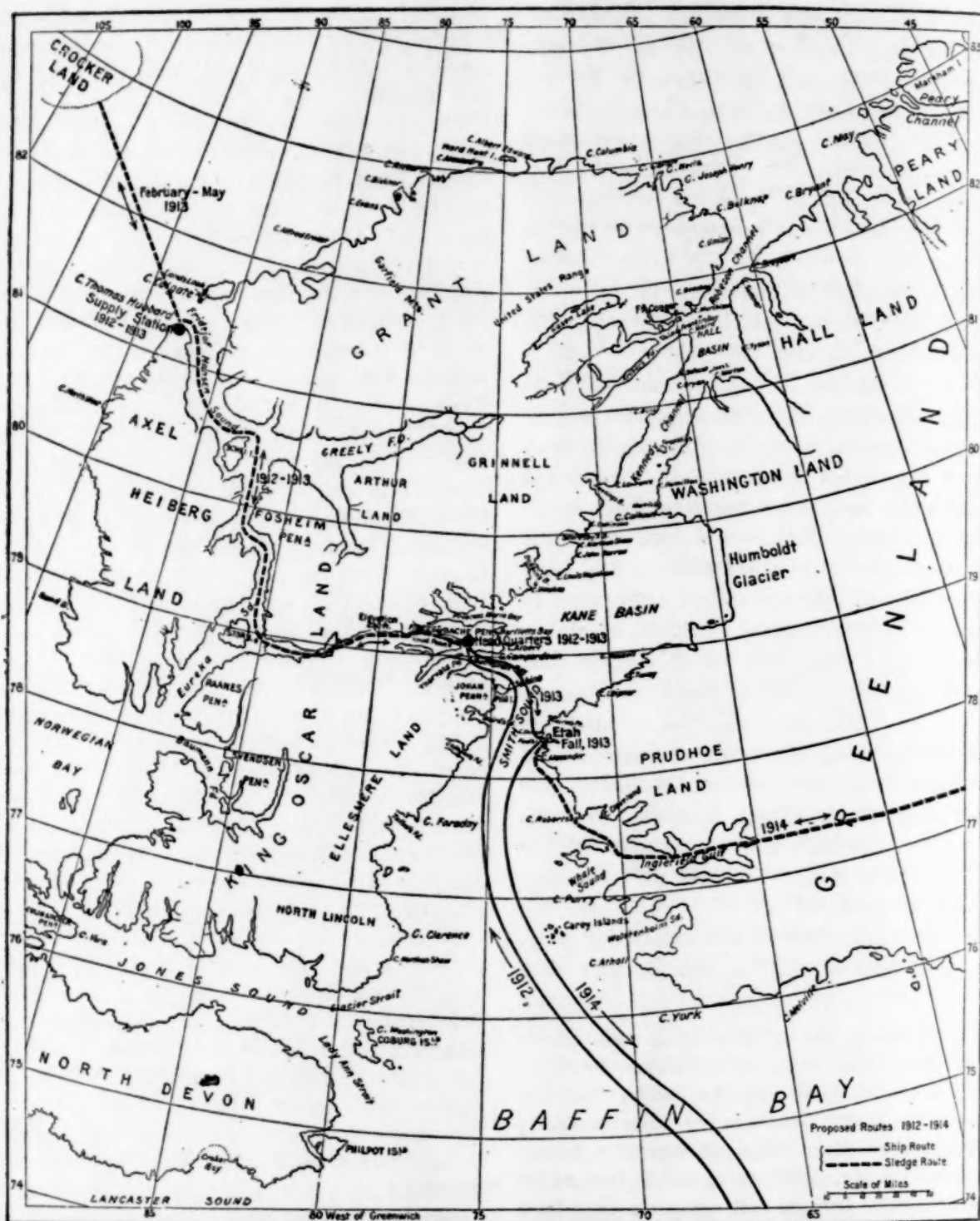
Belief in the existence of a land mass northwest of Grant Land rests on deductions made by Harris and observations made by Peary. Admiral Peary in his book "Nearest the Pole" reports having seen the "faint white summits of a distant land" on 24 June, 1906, from 2,000 feet above sea level on Cape Colgate and again six days later from 1,600 feet altitude on Cape Thomas Hubbard. It was calculated that this land lay about 130 miles out in the polar sea and in 100° W. Long. and 83° N. Lat. To it Peary gave the name Crocker Land. Dr. R. A. Harris in his monograph on "Arctic Tides" (1911) gave his reasons for concluding from a plotting of the cotidal lines of the Arctic regions that a great tract of land, an archipelago or an area of shallow water, trapezoidal in outline and half a million square

(statute) miles in area lies north of eastern Siberia and northern America. He places one corner of his trapezoid northwest of Grant Land and identifies Peary's Crocker Land with it.

The new expedition proposes to make soundings along the line from Cape Thomas Hubbard to Crocker Land, to determine the situation of the continental shelf, to collect samples of the ocean floor and to take temperature observations of the water at various depths and by attaching a small net to the sounding wire, to obtain specimens of oceanic life. These soundings, taken in connection with those made by Admiral Peary between Cape Columbia and the Pole, and by Nansen on the drift of the Fram starting in latitude 78° 50' north, longitude 133° 37' east, north of Siberia, to 85° 57' and thence down the west coast of Spitzbergen, will give a fair idea of the configuration of the floor of the Arctic seas. Tidal observations will be made at Cape Thomas Hubbard and at such points on Crocker Land as are found to be practicable. Such observations are highly desirable as supplementary to the records already secured on the north coast of Greenland and Grant Land by Marvin, MacMillan and Borup in connection with the last Peary expedition. On Crocker Land itself it is proposed to make a topographic map of the coast line and of parts of the interior, and if feasible to map geologically such parts as are visited; but in any case, to note the stage of physiographic development, the formations represented, and to collect specimens of rocks, of fossils and of living plants and animals.

In order to increase the scientific value of this expedition and in order that it may yield definite scientific results in the event of failure to reach Crocker Land, it is proposed to explore and to make detailed scientific observations in Ellesmere Land, Grant Land and Greenland. A part of the north coast of Grant Land will be studied and during one summer or late spring it is proposed to make a trip from Whale Sound (Inglefield Gulf) directly east into the interior of Greenland. By taking this course, the height of the ice cap may be ascertained and observations made of this great ice sheet supplementary to those of Peary, Nansen and Nordenskiöld. Nansen's studies were slightly south of the Arctic circle where the land is not very wide. The two journeys of Peary from Whale Sound to Independence Bay were made relatively near the shore.

After consultation with various scientists as to what classes of work will yield the greatest return, it is proposed to make the following studies:



THE PROPOSED ROUTE OF THE CROCKER LAND EXPEDITION

(a) *Geography*.—The coast lines and interiors will be mapped by plane table, barometer, continuous tracing of valleys, etc.

(b) *General Geology*.—Observations on the geology of Ellesmere Land and Grant Land have been made by the Norwegians under Sverdrup and the English Expedition of 1875-6, but their work was

necessarily of such a preliminary character that very little concerning the age of the formations and the relative abundance and character of the igneous and sedimentary rocks was learned; and nothing concerning the physiographic conditions of these areas was determined. It is proposed therefore to make detailed areal studies of the geology

of these regions and to make rather complete collections wherever possible.

The scattered paleontological data in this region which now are of small value could be made of much greater significance by studies such as are proposed. Along physiographic lines practically nothing has been done and the broad question of cycles of erosion, involving possible climatic changes furnishes a fascinating subject of study of far-reaching scientific importance. The structure of these areas as indicating the character and extent of the larger earth movements in the Arctic regions and the original structures of the larger land masses could be determined by such studies as we propose.

(c) *Glaciation*.—It is proposed to make a thorough study of glaciers, glacial motion and the process of erosion by glacial ice caps. The geological importance of ice in molding land forms has been studied in existing glaciers, but the process of land molding under a continuous moving ice cap is not understood and there is here an opportunity for making observations which are significant not only for the present geological era, but also for Permian and Cambrian eras. It is proposed to make a special study of the so-called "glacial fringe" on the shores of the polar sea which to a limited extent resembles the great Ross Barrier of the Antarctic. The land and sea ice meet on the north coast of Grant Land, about five miles off shore. The land ice or "glacial fringe" is not a true glacier, but a combination of glaciers from the land and the heavy ice of the fiords which merge into a sort of piedmont glacier. There are no crevices in the ice surface aside from "tidal cracks," but it is thrown into great swells or waves 30-40 feet high and from a few hundred yards to a mile in length, which run generally normal to the shore. From this fringe come the floe-bergs and many heavy ice floes of the polar seas. This "glacial fringe" forms a unique and interesting feature of glaciation, and a study of its character and effects is of the highest importance to glacialists. In this connection attention has been called to an interesting feature by Colonel Feilden, the naturalist to the English Arctic Expedition of 1875-6, who says: "There is a lot of drift wood knocking about. I got it from off the floes up to 1,000 feet elevation—the interesting question is whether it comes from the Mackenzie or from Siberia? I do hope they will make a most careful investigation of the raised beaches and their contents. Also the birthplace of those mysterious boulders which are strewn along the

shores and to high altitudes in Grand Land and North Greenland."

(d) *Meteorology*.—It is proposed to make continuous barometric and thermometric observations at all points visited and an endeavor will be made by use of box kites to secure data as to temperature and direction of the upper air currents. No work of this sort has been previously done in such high latitudes, and it is probable that interesting data regarding atmospheric circulation will be obtained.

(e) *Tidal Observations*.—As stated before, observations will be made at Cape Thomas Hubbard and at points on Crocker Land. Mr. O. H. Tittman, superintendent of the Coast and Geodetic Survey, in a letter says, "Tidal observations, if carefully made for even a few days at a place, will be appreciated at this office. The localities in which such information appears to be most desired are: Axel Heiberg Island, Greeley Fiord, northwest coast of Grant Land, any undiscovered land to the northwest of Grant Land, the north coast of Greenland at points between Cape Bryant and Cape Morris Jesup. Any soundings which may be taken to the north of known land will be of interest to this office and to geographers generally."

(f) *Ichthyology*.—Hitherto practically no fish have been caught in these waters by any of the previous expeditions except a variety of salmon trout found in fresh water lakes. The fish do not seem to rise to bait.

In Smith Sound and Kane Basin there are great numbers of fish, however, as proved by the innumerable seals found there. Their chief diet is fish. Numerous good-size fish bones were also found in the stomachs of narwhals killed by Peary's last expedition.

By taking nets, trawls, etc., along, fish new to science may be caught and in all events we can prove what kind of fish inhabit these waters.

(g) *Ethnology*.—The Eskimos will be studied, their mode of life, traditions and language. It is planned to take a phonograph and make records of their language, songs, etc.

It is also intended to use the new adaptation of color photography to moving pictures in depicting various phases of animal life. This has never been done in the Arctic. Many very interesting and valuable moving pictures of the life in the north remain to be taken, such as camp life, building igloos, driving dogs, hunting and especially a good walrus fight.

(h) *Ornithology*.—Complete collections of eggs and birds will be made. Photographs of the nest-

ing places and the young will be taken; moving pictures showing the marvellous abundance of bird life, etc., will be secured.

(i) *Mammalogy*.—Specimens of all kinds of animal life will be secured, including bear, foxes, deer, mush oxen, hare, lemmings, walrus, and several kinds of seals. Measurements of narwhals and white seals will be made to supplement those taken by Mr. Roy C. Andrews in the Pacific.

The plan of campaign as laid down by Messrs. Borup and MacMillan is as follows:

Leave Sydney, N. S., by special steamer about 20 July, 1912. Collect whale and walrus meat and dogs on the way northward. Land on the south side of Bache Peninsula (Flagler Bay), Lat. $79^{\circ} 10' N.$, and establish winter quarters. Send the ship home. About the middle of September, begin sledging supplies to Cape Thomas Hubbard, and carry the work on throughout the winter during the moonlight periods. Leave Cape Thomas Hubbard with the return of dawn in February, 1913, and push across the ice to Crocker Land. Leave Crocker Land about 1 May, and return to Cape Thomas Hubbard. Send a messenger to North Star Bay with news of the expedition, to be forwarded by Danish steamer to civilization. Carry on scientific work in Grant Land and along return route to winter quarters on Flagler Bay, arriving there in July, 1913. During the summer, transfer supplies and collections to Etah. In the spring and summer of 1914, make an expedition from Whale Sound (Inglefield Gulf) directly eastward to the summit of the ice-cap of Greenland, at the widest part of that island. Return to New York in the autumn of 1914 by special ship.

The following are some of the principal items of the outfit to be provided: three years' provisions for four or five white men, their helpers and their dogs, much of which, particularly the pemmican, has to be specially prepared and packed; clothing; instruments for all kinds of observations and records; photographic cameras, including those for moving pictures; a power boat for use in Flagler Bay and in crossing to Etah with supplies and collections after the return from

Crocker Land; salary of physician and wages of cook and helpers; a steamship to take the party to Flagler Bay in 1912 and another to go up for it in 1914.

A physician and a zoologist are needed to accompany the party throughout the whole expedition.

It is estimated that not less than fifty thousand dollars (\$50,000) must be provided for the absolute needs of the expedition, in order to enable it to accomplish the valuable results that have been outlined above, in spite of the fact that Messrs. Borup and MacMillan generously serve the expedition without salary during the period of its absence from New York. Subscriptions to the fund are invited. Checks should be made payable to and all correspondence should be addressed to the American Museum of Natural History.

In addition to the support of the institutions already named, subscriptions have already been made or promised by Yale University, Bowdoin College, New York Academy of Sciences, Groton School, Theodore Roosevelt, R. E. Peary, Thomas H. Hubbard, Zenas Crane, Mrs. C. B. Alexander, John E. Thayer and others. There remains to be raised about thirty thousand dollars, and the museum has opened an account, known as the "Crocker Land Expedition Fund," for the purpose of receiving and caring for all subscriptions made to the expedition. Checks to further its purposes should be drawn payable to the American Museum of Natural History and forwarded to that institution. A list of subscribers will be published later and will be included in the final report.

The honorary committee on the Crocker Land Expedition consists of Henry Fairfield Osborn, president, American Museum of Natural History; Chandler Robbins, chairman of the council, American Geographical Society; Thomas H. Hubbard, president, Peary Arctic Club.

The committee in charge comprises E. O. Hovey, American Museum of Natural History; H. L. Bridgman, Peary Arctic Club.

All correspondence regarding the expedition should be addressed to Dr. Hovey.

GEORGE JARVIS BRUSH

GEORGE JARVIS BRUSH, LL.D., professor of mineralogy, emeritus in Yale University, died at his home in New Haven on February sixth in his eighty-first year. He was the last survivor of the first class to graduate from the Scientific School and the last member of a small group of distinguished men, who in the early days of the school devoted their lives to its service. With him passes a scientist who did much for the development of the science of mineralogy in this country and one who did even more for the general cause of scientific study and research.

He was born in the city of Brooklyn, December 15, 1831. An illness when a boy forced him to spend a year in the country and from this arose an interest in agricultural problems which later led him to Yale to take the newly established course in agricultural chemistry taught at that time by Professor J. P. Norton. In this way he became deeply interested successively in the subjects of chemistry, metallurgy and mineralogy. He entered Yale in 1848, leaving in 1850 to become an assistant in chemistry to Professor Benjamin Silliman, Jr., at Louisville. He received, however, in 1852 the degree of Bachelor of Philosophy with his class at Yale. In the same year he became an assistant in chemistry at the University of Virginia. It was here that he did his first important work in mineralogy in collaboration with Professor J. Lawrence Smith. Together they published a series of articles entitled "Reexamination of American Minerals," in which many new analyses were given and many points clarified which had been obscure in the early descriptions of American minerals. In 1853 Brush went abroad and spent two years of study in the laboratories at Munich and Freiburg. He returned to New Haven in 1856 as professor of metallurgy, which title he retained until 1864, when it was changed to professor of metallurgy and mineralogy. In 1871 the title was again changed to professor of mineralogy and this was retained until his death, the word emeritus being added in 1898 when he retired from active duties. He was deeply in-

terested in the development of the new scientific school in which he taught and was largely instrumental in its incorporation as the Sheffield Scientific School in 1861. He became the first director of the institution in 1872 and retained that office until his resignation in 1898. The earlier years of this period were critical ones, not only for the Sheffield Scientific School, but for the general cause of scientific education in this country. It is to be remembered that the public sentiment toward science was very different then from what it is to-day. At that time men like Professor Brush were especially needed who, with courage and far-sighted ideals, could strive against and gradually overcome the general distrust and disfavor with which scientific education was considered. In the scientific school he gathered a faculty of notable men about him and through his enthusiasm and faith inspired them with a devotion and unity of purpose which has had few parallels.

Much of his power lay in his ability to successfully organize and direct. That he had a keen business sense is shown in the material advancement of the school under his leadership and also in the fact that his services were always in demand by various public business organizations as a director and officer.

In his younger days, before his administrative duties became too heavy, Brush did considerable investigation in mineralogy, as the appended bibliography will show. He was, furthermore, always an inspiration to other workers in that field. It was through his enthusiasm and interest that the remarkable mineral locality at Branchville, Connecticut, was thoroughly explored. The results of these investigations were published in a series of papers by him in collaboration with Professor E. S. Dana. The work also involved a series of chemical analyses by S. L. Penfield and H. L. Wells, who were at that time graduate students in the Scientific School. Penfield later became assistant to Brush and finally succeeded him as acting professor of mineralogy

when administration duties compelled the latter to relinquish his teaching.

Brush also did much important work along the lines of the systematization of mineralogy. He wrote the eighth, ninth and tenth supplements to the 4th edition of Dana's "System of Mineralogy." He assisted in the preparation of the 5th edition of that book and wrote its first appendix. In 1874 he published his "Determinative Mineralogy and Blowpipe Analysis," a book which passed through fourteen editions until 1898 when it was revised by S. L. Penfield.

He commenced to assemble a mineral collection when a boy of fifteen years of age. His first specimen, which is still preserved, was collected at Salisbury, Connecticut, in 1846. This was the nucleus of what has since grown to be a collection of more than fifteen thousand specimens. The Brush Mineral Collection, as it is called, is in many ways unique. The idea that its founder always had in mind was to make it a collection for study rather than one for exhibition. It does not include, therefore, as many large or striking specimens as some of our public collections, but is, on the other hand, particularly rich in representative and type material. It is the repository of most of the minerals which have been the subject of investigation at Yale during the last forty years. From the viewpoint of the student of mineralogy, therefore, it ranks high among the mineral collections of the world. Together with a large mineralogical library it was given to the Sheffield Scientific School in 1904 accompanied with an endowment fund to provide for its future maintenance. The Brush Mineral Collection will therefore always remain one of the treasures of Yale and form a notable monument to its founder.

Professor Brush was elected a member of the National Academy of Sciences in 1868 and received the degree of Doctor of Laws from Harvard University in 1886. He was president of the American Association for the Advancement of Science in 1880. He was an honorary member of the Mineralogical Society of England, was a foreign member of

the Geological Society of London, of the Geological Society of Edinburgh, of the Royal Bavarian Academy of Sciences of Munich and various other learned societies, both at home and abroad.

It is seldom that we have a man of such wide influence along so many different lines who can combine, as he did, the activities of the scientific investigator, the duties of the organizer and the services of the public-spirited citizen. His character, combining, as it did, the scientist's demand for truth and accuracy with the kindly spirit of the broad-minded gentleman, was an inspiration to all who knew him. His optimism, his generous nature, and his readiness to serve were qualities that endeared him to his colleagues and to the many students with whom he came in personal contact.

PUBLISHED WORKS OF GEORGE JARVIS BRUSH

1849. "Analysis of Albite," *Amer. Jour. Sci.*, Vol. 8, p. 390.
"Analyses of Indianite," *Amer. Jour. Sci.*, Vol. 8, p. 391.
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"Analyses of American Spodumene," *Amer. Jour. Sci.*, Vol. 10, p. 370.
1852. "Fluor of Illinois," *Amer. Jour. Sci.*, Vol. 14, p. 112.
1853. "Reexamination of American Minerals" (with J. Lawrence Smith), three papers, *Amer. Jour. Sci.*, Vol. 15, p. 207, Vol. 16, p. 41 and p. 365.
1854. "Chemical Composition of Clintonite," *Amer. Jour. Sci.*, Vol. 18, p. 407.
"Test for Zirconia," *Amer. Jour. Sci.*, Vol. 18, p. 415.
1855. "On Prosopite," *Amer. Jour. Sci.*, Vol. 20, p. 273.
1857. "On Dechenite," *Amer. Jour. Sci.*, Vol. 24, p. 116.
"On Parathorite," *Amer. Jour. Sci.*, Vol. 24, p. 124.
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1858. "On Chalcodite," *Amer. Jour. Sci.*, Vol. 25, p. 198.
"Mineralogical Notices," *Amer. Jour. Sci.*, Vol. 26, p. 64.

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1861. Ninth supplement to Dana's "Mineralogy," *Amer. Jour. Sci.*, Vol. 31, p. 354.
"On Crystalline Hydrate of Magnesia," *Amer. Jour. Sci.*, Vol. 32, p. 94.
1862. Tenth supplement to Dana's "Mineralogy," *Amer. Jour. Sci.*, Vol. 34, p. 202.
"On Amblygonite from Maine," *Amer. Jour. Sci.*, Vol. 34, p. 243.
"On Triphyline at Norwich, Mass.," *Amer. Jour. Sci.*, Vol. 34, p. 402.
1863. "On Childrenite," *Amer. Jour. Sci.*, Vol. 36, pp. 122, 257.
"Tucson Meteoric Iron," *Amer. Jour. Sci.*, Vol. 36, p. 152.
1864. "On Tephroite," *Amer. Jour. Sci.*, Vol. 37, p. 66.
1865. "On Artificial Diopside," *Amer. Jour. Sci.*, Vol. 39, p. 132.
1866. "On Cookeite and Jefferisite," *Amer. Jour. Sci.*, Vol. 41, p. 246.
"New Mineral Localities," *Amer. Jour. Sci.*, Vol. 42, p. 268.
1867. "Native Hydrates of Iron," *Amer. Jour. Sci.*, Vol. 44, p. 219.
1868. "On Sussexite," *Amer. Jour. Sci.*, Vol. 46, pp. 140, 240.
1869. "On Hortonolite," *Amer. Jour. Sci.*, Vol. 48, p. 17.
"On Durangite," *Amer. Jour. Sci.*, Vol. 48, p. 179.
"On a Meteoric Stone from Alabama," *Amer. Jour. Sci.*, Vol. 48, p. 240.
"On the Magnetite on the Pennsbury Mica," *Amer. Jour. Sci.*, Vol. 48, p. 360.
1871. "On Gahnite of New Jersey," *Amer. Jour. Sci.*, Vol. 1 (3d series), p. 28.
"On Ralstonite," *Amer. Jour. Sci.*, Vol. 2, p. 30.
1872. Appendix to the fifth edition of Dana's "Mineralogy." New York.
1873. "On Anglesite from Arizona," *Amer. Jour. Sci.*, Vol. 5, p. 421.
1874. "Manual of Determinative Mineralogy." New York.
1876. "On Durangite," *Amer. Jour. Sci.*, Vol. 11, p. 464.
- 1878-90. "On the Mineral Locality at Branchville, Connecticut" (with Edward S. Dana), five papers, *Amer. Jour. Sci.*, Vol. 15, pp. 398, 481; Vol. 16, pp. 33, 114; Vol. 17, p. 359; Vol. 18, p. 45; Vol. 20, pp. 257, 351; Vol. 39, p. 201.
1880. "On the Relation of Childrenite and Eosphorite" (with Edward S. Dana), *Amer. Jour. Sci.*, Vol. 19, p. 316.
"On Crystallized Danburite from Russell, N. Y." (with Edward S. Dana), *Amer. Jour. Sci.*, Vol. 20, p. 111.
1881. "On American Sulpho-selenides of Mercury," *Amer. Jour. Sci.*, Vol. 21, p. 312.
1883. "On Seovillite" (with Samuel L. Penfield), *Amer. Jour. Sci.*, Vol. 25, p. 459.

WILLIAM E. FORD¹

THE RAINEY AFRICAN EXPEDITION

MR. EDMUND HELLER, who represented the Smithsonian Institution on Mr. Paul J. Rainey's African Expedition, writes from Kisumu, British East Africa, January 26, 1912, that the expedition has been completed but that a delay has been caused in the shipment of specimens collected by Mr. Rainey and himself, due to the lack of porters, transportation facilities, etc. The collection, which arrived at Nairobi two weeks prior to the date of his letter, has been packed and forwarded by him to the Smithsonian Institution. While waiting for a steamer from Mombasa, Mr. Heller put in a couple of months in making collections at various stations of the Uganda Railroad, including some districts not touched by the Smithsonian Expedition under Colonel Roosevelt, and also about Lake Victoria Nyanza. By this means he has been able to add many species to the Smithsonian collection, as well as to finish a really complete survey of the mammals of British East Africa. He will probably spend a few weeks at the British Museum, and at the Berlin Museum, in comparing and identifying some of the specimens collected. The trip was most satisfactory in every way, and Mr. Heller estimates that the collection will rival that made by the Smithsonian African Expedition under Mr. Roosevelt in 1909 and 1910. In all there are about 700 large mammal skins in salt, 4,000 small mammal skins, and a large number of

¹ Assistant professor of mineralogy in the Sheffield Scientific School of Yale University and curator of the Brush Mineral Collection.

birds and reptiles, most of them coming from regions not visited by the previous expedition, while some are from remote localities never before visited by naturalists. After the completion of his studies in Europe, Mr. Heller will return to Washington, to complete his report on the mammals of British East Africa.

THE PACIFIC ASSOCIATION OF SCIENTIFIC SOCIETIES

THE second annual meeting of the Pacific Association of Scientific Societies will be held at Stanford University on April 4, 5, 6, 1912. Sessions will be held this year on one or more of the above days by the following eight societies:

- The Technical Society of the Pacific Coast.
- The Cordilleran Section of the Geological Society of America.
- The Seismological Society of America.
- Pacific Coast Branch of the American Historical Association.
- The Pacific Slope Association of Economic Entomologists.
- Pacific Paleontological Society.
- The Biological Society of the Pacific.
- The California Section of the American Chemical Society.

There will also meet with the Association the LeConte Club and the Mathematical Society of the Pacific Coast.

Friday evening will be used generally for dinners and banquets, and on Saturday evening will be held the general session of the association. President Jordan will give the address of welcome, and among the readers of papers will be Professor A. C. Lawson, University of California, Professor George Hempl, Stanford University, and Director W. W. Campbell, of the Lick Observatory.

The Pacific Association of Scientific Societies was organized in 1910 "to promote co-operation among the constituent societies." It is to make possible the getting together of a number of smaller isolated societies annually at the same time and place. The administrative machinery of the association is an Executive Committee composed of the presidents and secretaries, or their representatives, of the constituent societies. The principal business of this committee is to suggest

time and place of meeting and make arrangements for such meetings.

Nine Coast Societies became members the first year:

- The Technical Society of the Pacific coast.
- The Cordilleran Section of the Geological Society of America.
- The Seismological Society of America.
- Pacific Coast Branch of the American Historical Association.
- The Pacific Slope Association of Economic Entomologists.
- Pacific Coast Paleontological Society.
- The Philological Society of the Pacific Coast.
- The Cooper Ornithological Club.
- California Academy of Sciences.

The second year two more societies became members:

- The Biological Society of the Pacific.
- The California Section of the American Chemical Society.

The present officers of the association are:
Chairman of the Executive Committee, Mr. Otto von Geldern.

Vice-chairman, Professor George D. Louderback.
Secretary-treasurer, Professor J. N. Bowman.

The first meeting of the association was held at the University of California on March 31-April 1, 1911. The different societies accepting the suggested time and place, held their sessions on the campus; on Saturday evening the general session of the association convened in California Hall. At this session addresses and papers were given by Chairman Otto von Geldern, President Benjamin Ide Wheeler, President David Starr Jordan, Professor Vernon Kellogg, Mr. George W. Dickie and Professor Bernard Moses. The same general plan will be followed this year at the second annual meeting at Stanford University. The work of the various secretaries is greatly facilitated by the committee on arrangements appointed by President Jordan and composed of Professors Townley, Heath and Burlingame.

SCIENTIFIC NOTES AND NEWS

MR. SAMUEL HENSHAW has been appointed director of the Museum of Comparative Zoology of Harvard University.

PROFESSOR CHARLES JAMES, of New Hampshire College, has been awarded the Nichols medal of the American Chemical Society.

DR. A. E. ORTMANN, curator of invertebrate zoology, Carnegie Museum, and professor of physical geography, University of Pittsburgh, has been elected a member of the Halle Academy of Sciences.

MR. GUGLIELMO MARCONI has been appointed a life senator by the Italian government.

THE following fifteen candidates have been selected by the council of the Royal Society to be recommended for election into the society: Professor J. O. Arnold, Professor C. G. Barkla, Mr. L. Cockayne, Mr. A. L. Dixon, Sir T. L. Heath, Dr. H. O. Jones, Professor T. R. Lyle, Dr. W. McDougall, Mr. R. Messel, Professor B. Moore, Mr. E. Nettleship, Mr. R. Newstead, Vice-Admiral Sir H. J. Oram, Dr. G. T. Prior and Mr. R. C. Punnett.

THE following have been appointed members of the American Commission on Inorganic Nomenclature of Chemistry, to cooperate with similar national bodies of other countries: Jas. Lewis Howe, of Washington and Lee University, chairman; P. E. Browning, of Yale; E. C. Franklin, of the Hygienic Laboratory, Washington; A. M. Patterson, Xenia, O.; Chas. H. Herty, of the University of North Carolina; Owen Shinn, of the University of Pennsylvania, and Adolf Law Voge, of the Library of Congress.

AT its last meeting the Rumford committee of the American Academy of Arts and Sciences granted the sum of \$250 additional to a former appropriation to Professor Gilbert N. Lewis, of the Massachusetts Institute of Technology, in aid of his research upon the free energy changes in chemical reactions.

RECENT appointments to the research staff of the Otho S. A. Sprague Memorial Institute, Chicago, are Dr. Lydia M. DeWitt, formerly of the department of anatomy at the University of Michigan, and more recently of the health department of the city of St. Louis, and Dr. Samuel Amberg, of the department of pediatrics at Johns Hopkins Medical School.

DR. R. RAMSAY WRIGHT, vice-president of the University of Toronto and dean of the faculty of arts, will retire from active service on September 30. He has filled the chair of biology for the last thirty-eight years.

PROFESSOR EDWARD HICKING JACKSON, professor of orthopedic surgery at the Harvard Medical School, and Professor James Jackson Putnam, professor of diseases of the nervous system, have retired from active service and will be given the title of professor emeritus.

MR. N. E. DORSEY, Ph.D. (Hopkins, 1897), associate physicist in the U. S. Bureau of Standards, has been appointed research associate in the department of terrestrial magnetism of the Carnegie Institution of Washington.

DR. GEORGE A. HULETT, professor of physical chemistry, at Princeton University, has received leave of absence for the academic year 1912-13, in order that he may accept, for the year, the post of chief chemist in the U. S. Bureau of Mines.

MISS MARGARET HARWOOD, of the Harvard College Observatory, has been appointed to the astronomical fellowship of the Nantucket Maria Mitchell Association.

PROFESSOR W. BALDWIN SPENCER, F.R.S., has been appointed protector of the aborigines in the northern territory of Australia.

DR. SCHLAGINHAUFER has been chosen as the successor of Dr. R. Martin at the head of the Anthropological Institute, Zurich.

DR. W. J. HOLLAND, director of the Carnegie Institute, Pittsburgh, has been appointed by the Entomological Society of London to represent it at the centenary of the Academy of Natural Sciences of Philadelphia.

DR. A. HRDLICKA has been designated as the representative of the Smithsonian Institution at the eighteenth International Congress of Americanists, to be held at London from May 27 to June 1, 1912. Dr. Hrdlicka has also been accredited as a delegate to the congress on the part of the United States.

DR. C. H. EIGENMANN, curator of ichthyology at the Carnegie Museum, reports himself

as highly successful in his exploration of the Rio Magdalena and the Rio Atrato, in which he is making large collections of fishes for the museum.

MRS. T. D. A. COCKERELL has just returned from Guatemala, where she collected both in the mountains and in the tropical lowlands, and obtained a large collection of bees and other insects, as well as some reptiles, fishes, plants, etc.

DR. LOUISE B. WALLACE, associate professor of zoology at Mt. Holyoke College, has been granted two years leave of absence to take charge of the biological department in the American College for Girls in Constantinople.

DR. MAX BORN, of the University of Göttingen, is to lecture on relativity during the summer quarter at the University of Chicago. The course is to continue throughout the entire quarter.

PRESIDENT F. P. VENABLE, of the University of North Carolina, lectured before the Chemical Society of Washington and Lee University on March 1, on "The Value of Chemical Research."

DR. M. P. RAVENEL, of the department of bacteriology of the University of Wisconsin, is delivering a series of six lectures before the Milwaukee Medical Society on "Studies in Immunity, Vaccine and Serum Therapy."

PROFESSOR LAFAYETTE B. MENDEL, of the Sheffield Scientific School of Yale University, lectured before the students of Mt. Holyoke College on March 2, on "Changing Views on Nutrition."

At a meeting of the Geographical Society of Chicago on March 8, a lecture was given by Mr. Alfred H. Brooks of the U. S. Geological Survey, the title of the lecture being "Geography of Alaska."

PROFESSOR J. G. D. MACK, the exchange lecturer from the University of Wisconsin, gave two lectures before the students and faculty of the College of Engineering of the University of Illinois on February 29. One lecture was on the engineering features of the Wisconsin Tax and Public Utilities Com-

missions. Professor Mack is a member of the engineering staff of these commissions. The second lecture was on some features of ancient engineering work and their relations to present-day practise, and was, in part, an appeal to engineering students to study the history of engineering as well as current practise.

DR. LYNDY JONES, associate professor of animal ecology in Oberlin College, lectured recently before the undergraduates in Spear Laboratory upon "The Winter Birds of Ohio." From now on to the end of the college year Dr. Jones is offering a seminar in practical field work in ornithology which has been elected by about ten advanced students.

DR. JOHN BERNHARDT SMITH, state entomologist of New Jersey and professor of entomology at Rutgers College, eminent for his contributions to entomology, died on March 12, aged fifty-four years.

PROFESSOR MASON BLANCHARD THOMAS, B.S. Cornell '90, Ph.D. '07, professor of botany at Wabash college since 1891, and dean of the faculty since 1907, died at Crawfordsville, Ind., on March 6, aged forty-six years.

DR. SAMUEL AUGHEY died in Spokane, Washington, on February 3, 1912, at the age of eighty-one. He was a graduate of Pennsylvania College, Gettysburg, and of the Theological Seminary of the same place. After some years in the ministry, during which time he moved with his family to Nebraska and soon became noted as an enthusiastic naturalist, he was elected to the chair of natural science in the newly established State University of Nebraska, where he remained for thirteen years. On severing his connection with the university, he devoted himself more especially to geology and the practical work of the mining expert. Among his publications are "A Catalogue of the Flora of Nebraska" (1875); "Physical Geography and Geology of Nebraska" (1880); "Geological Report on the Wyoming Oil Basins" (1881), etc.

PROFESSOR OSBORNE REYNOLDS, the distinguished engineer and physicist, for many years professor at the Owens College, died on February 21, aged seventy years.

SIR JOHN G. N. ALLEYNE, Bt., known as an authority in engineering and for his interest in iron and steel research, has died in his ninety-second year.

DR. A. H. YOUNG, emeritus professor of anatomy in the University of Manchester, died on February 22.

PROFESSOR RICHARD ANDRÉE, of Leipzig, known for his work in geography and ethnography, has died at the age of seventy-seven years.

THERE is existing a vacancy in the position of chief engineer, Indian Irrigation Service, at a salary of \$4,000 per annum. The requirements of the position are technical in their nature, the work having to do with the planning and construction of all the irrigation work under the control of the Office of Indian Affairs. The government is endeavoring to find the best man available for this work, and has no particular individual in view. The qualifications and fitness for this position, based upon education, training and experience in the design and construction of engineering works, will be determined by a board of experienced engineers. Qualified persons who are interested in this position are invited to communicate with the U. S. Civil Service Commission, Washington, D. C. The commission also announces a vacancy in the position of research bacteriologist in the biological laboratory of the Bureau of Science, Manila, Philippine Islands, at a salary of \$2,500 a year. This position is for a research bacteriologist with clinical experience, and applicants must be graduates in medicine; in addition they must show that they have specialized extensively in bacteriology and are capable of doing original research work. The work comprises investigations in tropical medicine in conjunction with the chief of the biological laboratory, who is also professor of tropical medicine in the College of Medicine and Surgery. The clinical material of the Philippine General Hospital and the hospital of the government prison will be available for study in connection with bacteriological investigation. It is stated by the Bureau of Science that opportunities exist for promotion

to higher places as vacancies occur, and at present there are six positions in this laboratory above the one in question, at salaries ranging from \$2,500 to \$5,000 a year. The library of the Bureau of Science and the equipment are of the very best and strictly modern, so that this position offers a unique opportunity for a young man who is ambitious to do research work.

THE treasurer of Columbia University has reported to the trustees that he had received about \$1,550,000 from the executors of the estate of the late George Crocker. Accordingly, the work of cancer research, for which Mr. Crocker gave this sum as an endowment, will begin at once. The research fund will be intrusted for administration to a board of managers, to consist of Mr. Rives, Dr. Cheesman and President Butler from the trustees, and Dean Lambert, Professors Janeway and MacCallum, of the medical faculty, together with a director of Cancer Research to be appointed.

THE Scripps Institution for Biological Research at San Diego is about to be made a part of the University of California. It was built up through the aid of Miss Ellen B. Scripps and Mr. E. W. Scripps. Control, heretofore in the hands of the San Diego Marine Biological Association, will be delegated by the University to Miss Ellen B. Scripps, Mr. E. W. Scripps, President Benjamin Ide Wheeler, of the university, and Dr. William E. Ritter, professor of zoology and director of the Scripps institution.

UNIVERSITY AND EDUCATIONAL NEWS

THE Brown University endowment fund has received a gift of \$10,000 from Mr. J. B. F. Herreshoff, an alumnus, vice-president of the Nichols Chemical Company of New York. This makes \$762,417 towards the million dollar fund.

THE budget of Columbia University calls for the expenditure of \$3,159,730.28 during the year beginning July 1. It is estimated that the income for the same period will fall short of meeting the expenditure by \$132,000, de-

spite the fact that the income on a large part of the John Stewart Kennedy bequest is now available. The largest single item of expense is for educational administration and instruction, \$2,180,402. Next to this come appropriations for buildings and grounds, the sum being \$332,593. The interest on the corporate debt will amount to \$114,870, while \$100,000 will be set aside and added to the redemption fund. Stated according to the various corporations of the university, the budget is divided as follows: Columbia College, \$2,101,512.28; Barnard College, \$217,725; Teachers College, \$803,470; College of Pharmacy, \$37,020.

A SPECIAL meeting of the Oberlin trustees was held on March 13 to consider plans presented by Mr. Cass Gilbert, of New York City, regarding the location of the new buildings made possible by the completion of the half million endowment. Mr. Gilbert's plans include a science quadrangle at the northwest end of the campus. Here it is proposed to erect four large laboratories to accommodate the departments of physics, zoology, geology and botany. Part of the equipment of the botanical building will be a series of greenhouses. The department of chemistry is already comfortably housed in a separate building, Severance Chemical Laboratory.

DR. HORACE DAVID ARNOLD has been appointed dean of the Harvard Medical School to fill the place made vacant by the resignation of Dr. Henry A. Christian.

DR. TALCOTT WILLIAMS, associate editor of the *Philadelphia Press*, has been appointed director of the School of Journalism of Columbia University, founded by Mr. Pulitzer. Professor John W. Cunliffe, now head of the department of English of the University of Wisconsin, is the associate director of the school.

DR. DOUGLAS W. JOHNSON, assistant professor of physiography in Harvard University, has been appointed associate professor of physiography at Columbia University.

DR. J. E. WALLACE WALLIN has accepted a

call from the University of Pittsburgh to organize a department of clinical psychology.

DR. MURRAY S. WILDMAN, A.B. (Earlham, '93), Ph.D. (Chicago, 04), now professor of economics and commerce in Northwestern University, has been appointed professor of economics in the Leland Stanford Jr. University, to fill the vacancy caused by the resignation of Professor Alvin S. Johnson, who goes to Cornell University at the close of the present academic year.

DR. H. W. FOOTE has been promoted to be professor of physical chemistry in the Sheffield Scientific School of Yale University.

DISCUSSION AND CORRESPONDENCE

THE CORN SNAKE IN NEW JERSEY

WHILE at Chatsworth, Burlington County, N. J., on July 11, 1911, I called on Mr. George Bozarth, the hotelkeeper, who buys up local snakes, excepting rattlesnakes, of which there are still a few in that part of the pine barrens. Noting that the box where he kept his reptiles contained only pine and king snakes, I inquired if he had any other species. He replied that he had but the day before thrown out a corn snake, which had died. He added he had but few of that kind brought in, but that they were to be occasionally met with in the vicinity. After some search we found the reptile, which was still in a good state of preservation and which I showed to various people living near Jones's Mill, a short distance to the east of Chatsworth, eliciting the information that the corn snake occurred in the vicinity, but was far rarer than the pine snake.

My specimen has the dorsal rows of scales weakly keeled, as described by Cope, and the color pattern also fits the description admirably. It has also been compared with living specimens in the New York Zoological Park. It is thirty-four inches in length.

In the "Amphibians and Reptiles of New Jersey," by Henry W. Fowler, published in the Annual Report of the New Jersey State Museum for 1906, I do not find the corn snake, *Coluber guttatus* Linn., recorded, nor

is it mentioned in the supplements that have since been published. Cope says:

This species ranges the Austroriparian region east of the Mississippi River, and the Carolinian district of the Eastern, not, however, entering New Jersey.

It appears, however, from the above record that there is at least one colony of corn snakes to be found in the pine barrens of New Jersey.

NEW BRIGHTON,

WM. T. DAVIS

STATEN ISLAND, N. Y.

FUNDULUS AND FRESH WATER

THE notes which have recently appeared in SCIENCE in regard to the capacity of salt-water minnows to survive being transferred to fresh water, remind me that the experiment has been, and I suppose still is tried, on what I may call a commercial scale, in southeastern Massachusetts. "Mummichugs" (*Fundulus* spp.) are the favorite, practically the only, bait for winter pickerel fishing through the ice, and it was a very common practise to catch them in large quantities in salt water in the late fall, and keep them in running fresh water all winter.

When I lived on a farm in Middleboro, Mass., in 1892-96, one of my neighbors always had them for sale, during the pickerel season. He used to catch them in Buzzard's Bay, some fifteen miles away, and kept them in a perforated box, placed in a running brook. I have more than once bought "Mummichugs" from him, and, if my memory does not play me false, have kept them alive for some time in a boxed-in spring on my farm. They must have been in confinement at least a month, but seemed in perfect health and were very vigorous and active. Had there been any serious mortality among them, it certainly would not have paid him to keep them for sale.

As a matter of fact, I believe that live *Fundulus* for bait are to be had regularly in the Boston fish markets every winter, and my impression is that they are kept in tanks fed with ordinary tap water.

I may add that I use a good many "Mum-

michugs" for live bait every summer, and find them remarkably tenacious of life. If covered with wet seaweed, they keep lively for several hours even in hot weather.

JOHN MURDOCH

PUBLIC LIBRARY,
BOSTON, MASS.

SCIENTIFIC BOOKS

Vergleichende Physiologie. By AUGUST PÜTTER. Jena, G. Fischer. 1911. Pp. 721; illustrations 174.

The title of this book, "Comparative Physiology," is misleading and the author, who is a professor at Bonn, endeavors to justify it in his introduction. The task of general physiology, he says, is the investigation of the general problems of life; comparative physiology is a method, the object of which is to enable one to comprehend the fundamental physiological similarities of organisms. The book therefore does not rehearse the physiological differences of species or larger groups, but deals with general physiology. "Allgemeine Physiologie" would have been a better title, had it not conflicted with that of his master Verworn's book. The facts are drawn chiefly from invertebrate animals and plants, a helpful list of which, with both scientific and common names, family, order and class, is given at the end. There are ten chapters, most of them long, rambling, and clumsily subdivided. In one case, the same heading is used for two distinct and separate sections. The index is wretchedly incomplete. Notwithstanding these technical defects, the book is a valuable addition to the growing literature of general physiology. It is very modern: most of its references to literature belong to the last decade; but again the great bulk of American physiology is unnoticed.

The morphological substratum of vital processes is passed over very briefly, only a few facts being presented regarding colloids, adsorption compounds, membranes, alveolar structure, and the chemical constituents of living substance. The term "living substance" is an abstraction; several kinds of

living substance are always combined to form a living system. The simplest living system is the cell, which comprises at least three structural substances, plasm, nucleus and membrane. More than one quarter of the text is devoted to metabolism. Here the author's tendency to avoid the conventional, which is evident throughout the book, is at once illustrated by his sharp separation between "Baustoffwechsel," and "Betriebsstoffwechsel," comprising respectively the metabolic processes involved in the building of body substance and those not so involved. The actions on metabolism of such conditions as temperature, light, altered concentration of food stuffs, hunger, absence of oxygen, and accumulated metabolic products are discussed. In a subsequent chapter on nutrition, the author presents with experimental evidence his theory that many aquatic animals are nourished by organic food dissolved in the surrounding water, and maintains that this has now been proved for many coelenterates, entomostracans, tunicates and some fishes. Resorption is discussed from the modern standpoint. The chapter headed "Exchange of Matter," allows a modern treatment of such general physiological topics as the resorption of oxygen and of solid substances in solution, the exchange of water, excretion, secretion, and the distribution of matter in plants and animals. Here many of the facts and principles of respiration, excretion and circulation are introduced, but there is no attempt to treat these topics along the conventional lines of vertebrate physiology. The chapter on the conditions of life ends with a discussion of the problem of the duration of life, with references to the work of Calkins and of Woodruff.

A separate chapter is devoted to transformations of energy and includes mechanical and chemical energy, light, electricity and heat. The author accepts Hürthle's ideas regarding the structure of muscle and, following Koltzoff's general conception of the relations of plasm and fibrillæ, believes the fibrillar rods to be elastic bodies which are under tension when the muscle is at rest. In contraction

there occurs a sudden change in the osmotic relations of the sarcoplasm and the isotropic disk, either a decrease of osmotic pressure in the former, or an increase in the latter; the membrane between the two undergoes an increase in permeability; water passes from the sarcoplasm to the isotropic substance; and the elastic tension of the fibrillar rods is released. Fröhlich's view of tonus is followed, according to which tonus represents a slight tendency to continuous contraction of a relatively small number of the fibers of a highly irritable muscle, resulting from the action of very feeble stimuli coming from nerve tissue. Contracture, on the other hand, is a purely muscular condition present in fatigued, narcotized and asphyxiated muscle, and represents a partial inability of all the muscle fibers to extend their elastic elements. The cilium, like the muscle fiber, contains an elastic and a plasmic constituent, and the interactions of the two result in the ciliary movement. Amœboid movement is probably similar in principle, the elastic element perhaps being represented by the superficial layer of the amœboid cell. The increase in the permeability of the plasmic membrane that occurs during contraction is associated with a reversible coagulation resulting from the action of the stimulus on metabolic processes.

Under the general heading of responses to stimuli the author discusses many of the current topics of general physiology, such as irritability, the law of the threshold of stimulation, the all-or-nothing law, conduction, the latent period, fatigue, the *treppe*, the refractory period, spontaneity, taxis and tropism, tonus, rhythm and the question of its myogenic or neurogenic origin, and the relation between irritability and metabolism. In many of these the author shows himself to be under the influence of the school of general physiology that is headed by Verworn. Sense organs are treated in a broad manner, attention being given not only to the various special senses of animals, but to analogous mechanisms in plants, such as the ocelli in leaves and the static relations of starch grains. In discussing the possibility of hearing by fishes a

warning is pronounced against a too wide generalization of the fact that a few species of fishes have been proved to react to tones. Sections are devoted to the chemical senses, with special reference to investigations on invertebrates, and to unknown senses.

It is in the treatment of the nervous system that the author breaks farthest away from conventional paths and takes a partisan stand on debatable ground. The neurone theory is not accepted, but throughout the whole nervous system there is a complete continuity of living substance. Neurofibrillæ are merely the skeleton of the nerve cell; the neuroplasm is the conducting part. Poisons have revealed the presence of at least six different kinds of living substance in the nervous system: the irritability of the end-organs of cross-striated muscle, of the end-organs of glands, the cardiac branches of the vagus nerve and of smooth muscle, and of sympathetic ganglion cells being depressed by curare, atropin and nicotin, respectively; the irritability of motor cells, intercalated cells and sense cells being augmented respectively by phenol, by strychnine and by neither phenol nor strychnine. Motor differ from non-motor cells in possessing less fatiguability, less need of oxygen and less sensitiveness toward narcotics. The central type of nerve substance is sharply differentiated from the peripheral type by various characteristics, such as its power of summation, certain peculiarities of its conductivity, its greater tendency toward fatigue and its greater need of oxygen—all of these differences, however, being quantitative and capable of being overcome by experimental devices. The author discusses the "adequate," or normal, stimuli for the successive nerve elements that partake in a reflex action, and raises the question whether internal secretions may not constitute the adequate stimuli for the cells of the sympathetic system. Reflex actions are discussed and numerous examples are cited to illustrate their principles. Brief sections are devoted to tonus, to inhibition, as to the theory of which no definite stand is taken, and to instincts; and the chapter ends with a dis-

cussion of the motor reactions of animals, which cites Yerkes's work. The final chapter deals with a comparison of organisms.

FREDERIC S. LEE

COLUMBIA UNIVERSITY

Star Lore of All Ages. By WILLIAM TYLER OLCOTT. G. P. Putnam's Sons. 1911. Pp. xxii + 453, illustrated.

The star groups or constellations, so fantastically figured in the ancient maps, are of unknown antiquity; they are found described in the earliest writers of the Greeks, and upon the tablets of Babylon. Around each group has collected a vast number of traditions, myths and legends; and these traditions Mr. Olcott has traced to their sources, the legends and myths he has collated, and has put all into a very readable form. The book is most attractively printed and illustrated and should be of interest to all who like to watch the stars.

CHARLES LANE POOR

COLUMBIA UNIVERSITY

SCIENTIFIC JOURNALS AND ARTICLES

THE opening (January) number of volume 13 of the *Transactions of the American Mathematical Society* contains the following papers:

E. Landau: "Ueber eine idealtheoretische Funktion."

R. G. D. Richardson: "Theorems of oscillation for two linear differential equations of the second order with two parameters."

E. J. Miles: "The absolute minimum of a definite integral in a special field."

E. G. Bill: "An existence theorem for a problem of the calculus of variations in space."

L. E. Dickson: "Linear algebras."

R. L. Moore: "A note concerning Veblen's axioms for geometry."

Joseph Lipke: "Natural families of curves in a general curved space of n dimensions."

F. R. Moulton: "A class of periodic orbits of superior planets."

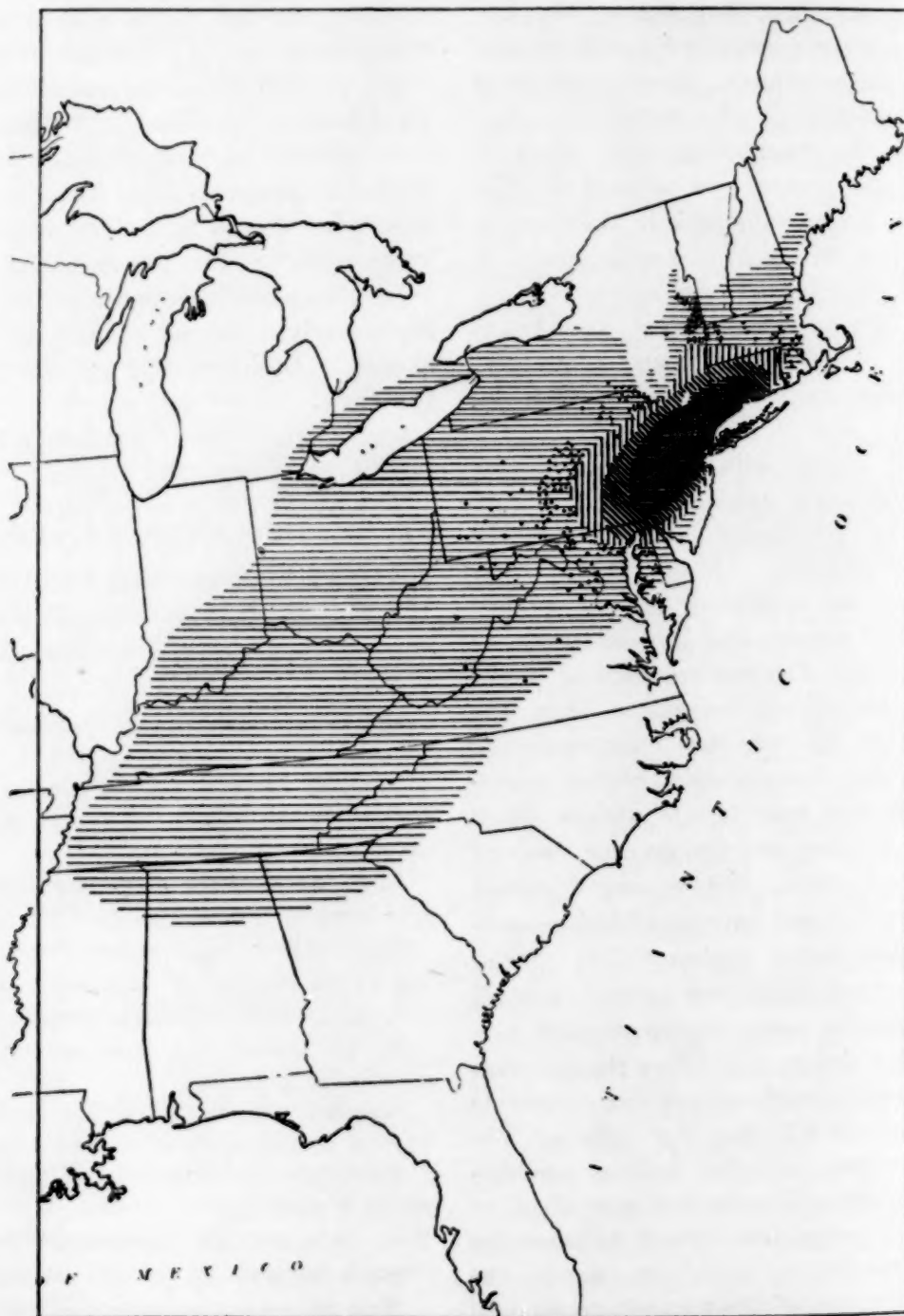
O. D. Kellogg: "Harmonic functions and Green's integral."

THE February number (volume 18, number 5) of the *Bulletin of the American Mathe-*

matical Society contains: Reports of the eighteenth annual meeting of the society and of the fifth regular meeting of the South-western Section, by the secretaries; "Series of Laplace's functions," by B. H. Camp; "On a new mixed problem of the partial differential equation of telegraphy," by A. G. Webster; "Non-Euclidean geometry" (review of Sommerville's "Bibliography of Non-Euclidean

Geometry"), by R. C. Archibald; "Notes"; "New Publications."

THE first number of a new architectural journal, entitled the *Architectural Quarterly of Harvard University*, will be published this month. The purpose of the periodical is to present in easily accessible form important work by students, special lectures delivered in the school, and contributions by members of



THE DISTRIBUTION OF THE CHESTNUT BARK DISEASE

the teaching staff and graduates. The principal article in the first number will be an illustrated paper on "Architectural Acoustics" by Professor W. C. Sabine, with a practical discussion of a number of recent theaters, lecture halls and churches. The number will also contain several drawings of important examples of European architecture and an essay on "The Mediæval Town Halls of Italy" by H. E. Warren, S.M. in Architecture, 1905. Early numbers of the *Quarterly* will contain examples of recent work in architectural design by students of the school, a paper on professional practise, the substance of three lectures recently delivered before the school by Mr. Cass Gilbert, of New York (lately president of the American Institute of Architects), and papers on the teaching of architectural design by Professor Duquesne, on the study of architectural history in its relation to the professional study of architecture by Professor H. L. Warren, and further papers on acoustics by Professor Sabine.

THE PRESENT KNOWN DISTRIBUTION OF THE CHESTNUT BARK DISEASE.

The writers published in *Farmers' Bulletin* 467, page 6 (issued October 28, 1911), a map showing the distribution of the chestnut bark disease as known in June, 1911. Since that time the disease has spread considerably, also our detailed knowledge of its distribution has increased. In the map here published, thin horizontal lines show the general distribution of uninfected *Castanea dentata*. Thick lines variously arranged in concentric bands indicate general regions of gradually increasing infection which culminate in the region of practically complete destruction of the tree about New York City. Black dots represent the location of advance infections, many of which have already been eradicated. The writers are under obligations to Dr. Perley Spaulding, Professor A. H. Graves, Mr. I. C. Williams, Mr. S. B. Detwiler and the members and employees of the Chestnut Tree Blight Commission of Pennsylvania, Mr. W. H. Rankin, Mr. J. F. O'Byrne, Mr. F. W. Besley, Dr. Ernest S. Reynolds, Mr. H. G.

MacMillan, Professor H. R. Fulton and Mr. A. B. Brooks, for much of the data used in compiling this map.

HAVEN METCALF,

J. FRANKLIN COLLINS

OFFICE OF FOREST PATHOLOGY,

BUREAU OF PLANT INDUSTRY,

WASHINGTON, D. C., February 1, 1912

SPECIAL ARTICLES

SENILITY IN MERISTEMATIC TISSUE

MERISTEMATIC tissue in perennial plants is commonly believed to retain its embryonic condition unchanged. Senility is considered to occur only in specialized cells. A twig cut from a mature tree and planted or grafted is said to produce a new tree as youthful in its protoplasmic vigor as a seedling. While these are almost the unanimous opinions of the botanists, it is interesting to note that many fruit growers and gardeners have always held that vegetatively propagated plants tended to run out, as if through senility.

In order to determine, if possible, which of these views is better justified, a series of investigations on meristematic tissue in perennials of different ages have been carried out, and this article is a brief preliminary statement of one of the more obvious results.

The structure of the adult leaves gives valuable insight into the meristematic tissue, since any minute changes occurring in the latter will be made larger and more obvious in the leaves, just as the inherent characteristics of seeds become more apparent in the plants into which they grow. If, therefore, the meristematic tissue of a perennial is changing with the increasing age of the plant, the new leaves appearing each year should reveal differences. In order to eliminate differences due to external factors, leaves were taken from cuttings of *Vitis riparia* of different ages grown under identical conditions. Comparisons were also made between leaves borne by vines growing wild, side by side under apparently identical conditions, and on many other kinds of trees and vines.

An interesting condition in the venation of the compared leaves was one of the results

noted and seemed to merit this preliminary note, because of the ease with which it may be recognized without apparatus by fruit growers as well as by botanists.

The smallest veinlets of the leaf form a continuous network and the meshes of this network are areas of parenchymatous tissue. The size of these areas is not only remarkably uniform in a mature leaf but is directly dependent upon the age of the plant upon which the leaf is growing. The older the plant, the smaller are the vein-areas of the leaf. This difference can be seen with a hand lens by holding the leaves up to the light. In *Vitis riparia*, for example, accurate measurements of hundreds of areas in leaves picked from different parts of the same vine, gave an average (vine 26 years old) area of .20398 sq. mm., while the largest measured .217 sq. mm. and the smallest .185 sq. mm. The comparison for leaves from vines of different ages is shown by the following table, which gives averages from leaves picked from many plants.

	4-5 Growth Rings.	6-12 G. R.	15-30.	35-50.
Cuttings of <i>V. riparia</i>44 sq. mm.	.35	.29	
Wild vines of <i>V. riparia</i> .	.42	.33	.24	.16

Even where the leaves are very large, as in the case of those borne on water-shoots from living stumps, the size of the areas is that characteristic of leaves borne on the tree the age of the stump. One of the several series of this kind follows:

Tree of <i>Castanea</i> <i>dentata</i>	8 Rings	15 R., Water- shoot	30 R.	Tree 50 R.
Size of area	.07 sq. mm.	.05 sq. mm.	.04 sq. mm.	.03 sq. mm.

The results with cuttings, water shoots and selected vines plainly indicates that the difference in size of areas is not due to external conditions. The reason that a leaf from a tree 25 years old differs in its venation from a leaf of a tree 10 years old is therefore that the meristematic tissue, in the two trees of the same species growing under the same conditions, is different. Apparently the meristem of the older tree produces less efficient spe-

cialized tissues than does the younger. The parenchyma is less permeable, the vessels less efficient in conducting; the sap must be brought into closer contact with all the leaf protoplasm. Since the amount of carbohydrate producing parenchyma is being gradually decreased by the inroads of the conducting system, the leaf is becoming a less efficient manufacturer of carbohydrate and ultimately the plant must starve.

If the changes in the size of the vein-areas be plotted as a curve, the nature of the resulting curve is the same as when the recognized senility changes in man and animals are plotted. It is interesting to note that changes in the vascular system in plants are due to the increasing senility of the meristem, just as changes in the vascular system of animals are due to senility. Dr. Osler says that "a man is as old as his arteries," and it may be said of plants that they are as old as their veins.

Since the leaves borne by cuttings showed but slight increase in the proportion of carbohydrate-producing tissue as compared with those on the original plant, it would appear that vegetative propagation can not and does not produce a young plant. The fact that the normal span of life for woody trees and vines extends in some cases over hundreds of years accounts for the fact that the approach of senility in vegetatively propagated plants is not more obvious. Plants which naturally reproduce by seed will tend to "run out" after long-continued vegetative propagation, ultimately dying of senility, and it is therefore incumbent upon our plant breeders to develop new varieties from seed, to take their place.

H. M. BENEDICT

UNIVERSITY OF CINCINNATI

THE WASHINGTON MEETING OF THE AMERICAN CHEMICAL SOCIETY.

DIVISION OF INDUSTRIAL CHEMISTS AND CHEMICAL
ENGINEERS

G. D. Rosengarten, *chairman*.

F. E. Gallagher, *secretary*.

H. C. SHERMAN, D. A. BARTLETT and N. E.
WEATHERLESS: *Relation of Ultimate Composi-
tion to Calorific Power in Coal.*

The analyses and calorific powers of 67 coals

from 17 states as published in Professional Paper 48 of the U. S. Geological Survey were considered. Estimates of calorific power by the usual formula

$$x = 8,080 C + 34,500 (H - \frac{1}{8} O) + 2,250 S$$

("Welter's rule")

gave results too low in seven eighths of the cases, the average result being 98.9 per cent. of the calorific power actually found.

The formula

$$x = 8,080 (C - \frac{1}{8} O) + 34,500 H + 2,250 S$$

("Walker's rule")

gave an average result 100.37 per cent. of the calorific power actually determined. The latter formula also showed a smaller proportion of serious errors in individual cases, and a smaller maximum error.

H. C. SHERMAN and S. H. REGESTER: *Relation of Proximate Composition to Calorific Power in Coal*. (Preliminary report.)

Analysis of the data for 500 samples of coal from different parts of the country are averaged to show the general course of the curve for calorific power of dry, ash-free substance with increasing proportions of volatile matter. As the proportion of volatile matter increases the mean deviations of individual samples from the average becomes greater. Where the volatile matter is over 48 per cent. of the dry ash-free substance the individual variations are so great as to deprive the average relation of any appreciable significance. Even with coals of low or moderate proportions of volatile matter, individual samples often differ from the average relation by 2 to 5 per cent. or more, so that if anything more than a crude approximation is desired the calorific power should be determined directly by combustion in a bomb calorimeter.

CHARLES E. MUNROE: *Note on the Production of Mercury Fulminate*.

Describes the preliminary steps taken in the production of substituted fulminic acids from the higher alcohols and of mercury fulminate and these substituted acids from acetaldehyde and the higher aldehydes.

CHARLES E. MUNROE: *The Present Status of the Gas Industry and Its Outlook*.

Attention was called to the fact that the centenary of the gas industry occurs in April, 1912, this being the one hundredth anniversary of the incorporation of the first Gas Light Company in London, England. The industry began in this country with the incorporation of the gas company in Baltimore in 1816. To-day there are 1,296

establishments in the United States, having a capital of \$915,537,000; employing over 50,000 persons; manufacturing 150,835,793 M. cubic feet of gas; and having a value for its products of \$166,814,000. To graphically depict the status and outlook of the industry a brief review of the various difficulties which it has encountered and the competitors which it has met and outranked was given, and it was admitted that the developments in the adaptation of electric energy to use presented now a more critical situation than the gas industry had perhaps ever before encountered; but he found in the development of the gas oven; in the employment of the chemical engineer; in the reduction of heat losses; in the more complete recovery of the by-products and their more complete utilization; and in the discovery and application of flameless incandescent surface combustion, means by which the gas industry could more than hold its own for a considerable time.

G. A. BURRELL: *New Forms of Gas Analysis Apparatus*.

This paper treats of gas analysis apparatus assembled by the author for work having to do with gas investigations carried on by the Bureau of Mines. Both accurate apparatus for use with mercury and apparatus for technical purposes are described. Exact and simple forms of apparatus for the examination of mine air and for use in ventilation studies are also described, both portable and laboratory forms. A special apparatus for the analysis of natural gas is also included. Also new apparatus for determining carbon monoxide by means of the iodic acid method.

F. M. WILLIAMS: *New Forms of Apparatus for Gas Analysis*.

J. T. BAKER: *Problems in Manufacture of C. P. Acids*.

This paper relates to the improvements made in recent years in the forms of apparatus for distilling acids on a larger scale. These are devised for working continuously by feeding the acid into the still as rapidly as the contents distills off and providing a gradual overflow for the tailings in order to remove the non-volatile impurities.

Apparatuses made of glass and porcelain are used and have a capacity of from 2,000 pounds to 4,000 pounds distillate in 24 hours. The advantages are less breakage with a minimum amount of labor and consumption of fuel.

J. R. CAIN and J. C. HOSTETTER: *A Rapid Method for the Determination of Vanadium in Steel, Ore, etc., based on its Quantitative Inclusion by the Phosphomolybdate Precipitate*.

Conditions are given for the quantitative precipitation of vanadium from solutions of steel, ores, etc., by coprecipitation with ammonium phosphomolybdate. Some methods of separating the vanadium from the precipitate are described. Attempts to determine the vanadium in the precipitate by Gregory's colorimetric method were unsuccessful. The vanadium may be reduced by sulphurous acid without reducing the molybdenum, and titrated against permanganate, but the method recommended by the authors is to reduce by hydrogen peroxide in concentrated sulphuric acid solution and titrate against permanganate, adhering closely to the conditions prescribed in the paper.

ERNEST BIDTEL: *Valuation of Fluorspar.*

Determinations usually required: Calcium-fluoride, silica, calcium-carbonate, sometimes lead, iron, zinc, sulphur.

Calcium-carbonate is determined by dissolving with ten per cent. acetic acid, taking the solubility of calcium-fluoride into consideration. Residue treated by yellow mercuric oxide to oxidize the sulphides, and silica volatilized by evaporation with hydrofluoric acid; loss in weight is silica.

Calcium-fluoride is eliminated without decomposing the ore. Iron oxide is transformed to iron-fluoride and separated together with lead and zinc sulphate by a solution of ammonium acetate containing ammonium citrate.

L. B. LOCKHART: *The Quality of Commercial Kerosene.*

PERCY A. BOECK: *Notes on a New Form of Extraction Thimble.*

Notes collected from various investigators on a new type of inorganic extraction thimbles and filters known as alundum. Manufacture described. Articles are made from bonded alundum grain, which is the product of the fusion of bauxite in the electric furnace and is practically pure fused alumina. Any texture, filtering capacity, melting point, tensile strength, etc., for any purpose can be obtained by varying method of manufacture. Articles filter rapidly, without any previous preparation and without changing the concentration of the solution, absorb only slightly, require little washing, and can be cleaned and sterilized by dry heating. Several types of extraction and filtering appliances for various kinds of work mentioned.

JOHN P. SIMMONS and O. J. TEEPLE, Jr.: *The Effect of Filtration upon the Physical Properties of Petroleum Oils.*

FREDERIC P. DEWEY: *The Direct Determination of Small Amounts of Platinum in Ores and Bullion.*

Platinum alloyed with silver being soluble in nitric acid, the solution obtained in parting gold from silver in ordinary assays is treated with a limited amount of hydrogen sulphide, after roasting, the precipitate is cupelled with a small amount of lead and the bead parted in strong sulphuric acid. Any platinum present will be left as a white metal, generally recognizable as platinum, but it may be tested to prove its identity or the presence of platinum metals.

FRANKLIN PEALE SUMMERS: *The Product Patent.*

This paper deals with the differences existing between our patent laws and those of the other countries with reference to the product patent on foods, drinks and medicinals. Practically all the other countries with the exception of England and the United States refuse to grant a product patent on the commodities above mentioned. The result is that, first, they permit competition on the necessities of their citizens, and secondly, they encourage the growth of chemistry in the respective countries, by opening and keeping open new fields for chemical research.

As long as these alien countries will not grant to an American citizen the same privilege that the United States grants to their citizens, it does not seem equitable that we should continue to grant the product patent on foods, drinks or medicinals.

In so doing our country continues to retard the growth of chemistry in a field that the other countries keep open. Thus in one product, aspirin, our citizens are annually paying a tribute to Germany of approximately two hundred thousand dollars, over and above what this same commodity sells for in Canada where no product patent is valid. This is due to the fact that in England and Germany the field for the production of acetyl salicylic acid is an open one and competition is permitted.

Were our country to change its patent laws so as to conform with these other countries in this respect, it would open a vast field in the production of organic synthetic compounds. We would be enabled to compete with these countries in an industry whose financial return is many millions of dollars. We would also offer still further inducement for the chemist, and by so doing we would more than ever narrow down the handicap now held by Germany for supremacy in chemical fields.

JAMES O. HANDY: *The Use of Potassium Cyanide Solution in the Investigation of the Structure and Conductivity of Copper, Copper-covered Steel and Other Metals.*

A 25-per-cent. aqueous solution of potassium cyanide dissolves, when boiled, an amount of copper equal to 5 per cent. of the KCy used. Steel and iron are almost insoluble in the same solvent.

Copper containing iron or arsenic shows a characteristic crystalline and colored appearance when etched with KCy solution. Pure cast copper is but slightly affected.

The structure of the "welded on" or "alloyed on" copper coverings of copper-covered steel wire has been studied by means of KCy solution. The "alloyed on" coverings have shown their impure nature. The conductivity of the composite wires and of the bare steel cores (after dissolving off the copper by KCy solution) showed in one case as follows:

	Steel Per Cent.	Copper Per Cent.	Conductivity of Composite Wire Per Cent.
"Welded" ...	77.20	22.80	36.20
"Alloyed" ...	56.00	44.00	34.00

The conductivity of the steel cores approximated 14 per cent. The low conductivity of the sample highest in copper shows its inferiority.

E. P. HARDING and E. JOHNSON: *An Apparatus and Improved Method for Determining Quantitatively Hydrogen Sulfide in Illuminating Gas.*

H. E. KIEFER: *Free Lime in Portland Cement.*

This paper cites numerous experiments to show that free lime is not the sole cause of disintegration of Portland cement as shown by the boiling test. If free lime is a real cause, as little as three tenths of one per cent. will cause rupture. Shows that carbon dioxide is not essential to seasoning and that the absorption of as little as one tenth of one per cent. of water will under certain conditions cure a very defective cement. That under other conditions neither water nor carbon dioxide is essential. Advances a theory of disintegration on physical lines to account for the seasoning of unsound cements.

W. C. TAYLOR and E. C. SULLIVAN: *Glass Analysis.*

A rapid method for analysis of glasses has been developed, depending on the decomposition of the glass by means of hydrofluoric and oxalic acids. Results for alkalis agree very well with those given by the Lawrence Smith method and results for lead, alumina, iron, manganese, lime, magnesia and zinc are accurate also.

The method of Wherry for the determination of boric oxide has been applied to glasses with necessary modifications where zinc or lead is present.

GEORGE L. HEATH: *The Estimation of Absorbed Gases and Oxygen in Copper by Ignition in Carbon Dioxide and Hydrogen.*

Thirty-seven years ago Dr. W. Hampe, of Germany, devised a process for the quantitative estimation of the percentage of oxygen in commercial copper by heating filings, or drillings, in an atmosphere of pure hydrogen gas in a hard-glass bulb tube, determining the loss in weight of the metal, and as an alternative the weight of water produced by the union of the hydrogen with the oxygen existing in the copper. Archbutt, Hofman and the writer have improved the process, but there is an error and omission in all published accounts, which it is important to correct by announcing the results obtained in a recent search for a method to show us, not only the oxygen, but also the original absorbed gases in all refined, or cast, copper of trade, which mainly consists of hydrogen (as hydride, or solid solution), with traces of carbon monoxide, carbonic dioxide, nitrogen, and possibly argon.

A separation which is accurate enough for analytical purposes is made possible by heating the copper, first, in carbon dioxide, for absorbed gases; secondly, in hydrogen to take out the oxygen; thirdly, in carbonic acid for a short time to take out considerable residual hydrogen, which would be, otherwise, retained.

Copper absorbs and retains but traces of pure carbonic acid, so that gas will expel hydrogen under heat. The first and third propositions have, hitherto, been overlooked.

DIVISION OF FERTILIZER CHEMISTRY

Paul Rudnick, *chairman*

J. E. Breckenridge, *secretary*

PAUL RUDNICK (chairman's address): *Fertilizer Chemistry—A Report of Progress.*

The consumption of commercial fertilizers for the year 1910 is estimated, in round numbers, at about 5,750,000 tons, an increase of approximately 14 per cent. over that of 1909. The average annual increase in the past decade has been close to 11.3 per cent.

The cost of ammoniates which supply the nitrogen in fertilizers has materially advanced, as the demand is greater than the supply. Inorganic ammoniates, including nitrate of soda, sulphate of ammonia and the products made from atmospheric

nitrogen by chemical and electrochemical processes, are produced in constantly increasing quantities, but organic ammoniates, including tankage, blood, etc., can not be produced in sufficient quantity to meet the demand and can not be entirely replaced by the inorganic sources of nitrogen for reasons involving mechanical condition, so that the fertilizer may be applied to the soil by suitable machinery. Much care and thought should be given to methods of control by state fertilizer authorities, so that arbitrary methods of analysis may not prevent the utilization of organic ammoniates which are now being wasted and thus the cost of the necessary organic ammoniates be forced up beyond all reasonable bounds. This is a matter of conservation of resources as well. The nitrogen of practically all the coal burned in this country should be recovered in the form of sulphate of ammonia.

In striking contrast to the demand for high availability of nitrogen is the proposal to use raw phosphate rock, the phosphoric acid of which is admittedly not available or at least so slowly that its application does not pay. It is highly desirable that commercial methods of producing available phosphoric acid from phosphate rock by cheaper and more efficient means than by conversion into acid phosphate should be found, although the Wisconsin Agricultural Experiment Station has recently pointed out that the sulphur in acid phosphate, present as calcium sulphate and produced by the treatment of phosphate rock with sulphuric acid, is a very necessary element in fertilizers, as much as and in some cases more so, than phosphoric acid.

The German potash controversy has stimulated renewed activity in the search for sources of commercial potash salts in this country, so that we may not be dependent upon Germany for this important constituent. The U. S. Geological Survey is now engaged in drilling a well, at Fallon, Nevada, as it seems likely that such deposits may exist in that region.

After discussing the various theories proposed to explain the action of commercial fertilizers, the possibility is pointed out that the results obtained from the use of commercial fertilizers may in part be due to a protective action which they exercise on the cells of the plant in some way similar to the action of the salts in sea water on animal organisms.

The need of a comprehensive and scientifically accurate theory of fertilizers is pointed out, so that wasteful and unscientific use may give way

to the most efficient and economical, hence most profitable, use.

BURT L. HARTWELL and F. R. PEMBER: *The Effect of the "Wet Process" on the Availability of Low-grade Nitrogenous Materials.*

In all, two crops of Japanese millet, two of oats and one of buckwheat were grown in pots on two different soils which were supplied with all the necessary non-nitrogenous manures. The amount of nitrogen supplied in the various nitrogenous materials which were tested was the same for each crop. Hair tankage, garbage tankage and roasted leather were used both before and after being subjected to digestion in the presence of phosphate rock and sulfuric acid (the "wet process").

The nitrogen of the garbage tankage had a very low availability both before and after acidulation; while that in roasted leather and hair tankage, although of low availability before, was much more available after treatment.

The treatment by the "wet process" of these nitrogenous materials individually was conducted in the laboratory, but a mixture of the three was treated by the regular "wet process" in a fertilizer factory. Over 70 per cent. of the nitrogen in the "base goods" so manufactured was soluble in water and highly available, but the insoluble nitrogen was of no immediate value.

F. B. PORTER: *A Method for Testing Out Problems in Acid Phosphate Manufacture.*

1.1 grams rock dust are weighed into 5" \times $\frac{3}{8}$ " test tube, known amount of acid added from Mohr's pipette. Stir three minutes, keep at any desired temperature for any desired time.

Transfer on to 9 cm. filter paper with water and determine insoluble phosphoric acid.

Average of three or four tests taken for result.

I. K. PHELPS: *Exact Work in Fertilizer Analysis.*

C. H. JONES: *Activity of Organic Nitrogen as Measured by the Alkaline Permanganate Method.*

The alkaline permanganate method for nitrogen activity is described in detail, together with the form now used for reporting results.

Results on fourteen different crude nitrogenous stock samples, 8 commercial fertilizers, and 13 mixtures of known composition are stated in tabular form, and explanations are given as to their interpretation from a standpoint of nitrogen activity.

A method is presented for determining the percentage of "nitrogen in the organic and volatile matter." Its application to fertilizers and crude stock as a means of determining whether the

organic nitrogen present came from materials rich or poor in that element is discussed.

H. G. BELL: *Fertilizer Economics.*

Advantages of mixed fertilizer are brought forth.

The fertilizer industry an essential factor in the business and life of the country.

European and American yields on wheat, oats, barley and potatoes are compared, showing Europe far ahead in crop yields.

North Atlantic states compared with middle Atlantic states shows gains for north Atlantic states in yield per acre due to rational use of mixed fertilizer.

Records of large gains by using fertilizer are given in Indiana and Ohio.

Sound economic principles as the basis of manufacture and sale of fertilizer are considered.

E. B. HART: *The Sulphur Requirements of Crops in Relation to the Soil and Air Supply.* (From the Laboratory of Agricultural Chemistry, University of Wisconsin.)

The average crop of cereal grains and straws removes about two thirds as much sulphur as phosphorus, mixed grasses remove the two in about equal proportions, while alfalfa removes about 60 per cent. more sulphur than phosphorus. Members of the Cruciferae, such as cabbage and turnips, may remove two to three times as much sulphur as phosphorus.

The superior results often obtained in the case of acid phosphate as compared with other sources of phosphoric acid may not be due entirely to the solubility of the phosphoric acid, but also to the additional sulphur supplied by the acid phosphate in the form of calcium sulphate. The idea that sulphur may become a limiting element in crop production would further account for the beneficial results obtained from gypsum, sulphate of potash and other sources of sulphur commonly contained in fertilizers.

J. P. STREET: *Note on the Neutral Permanganate Method for Availability of Organic Nitrogen.*

The adding of one gram of sodium carbonate to the neutral permanganate solution just before adding material to be tested largely overcomes the loss in availability when high-grade ammoniates are mixed with large proportions of acid phosphate.

Results on many organic ammoniates in presence of acid phosphate are given, showing that the method does differentiate between high and low grade materials.

A. J. PATTON and C. S. ROBINSON: *Conductivity Method of Making Neutral Ammonium Citrate Solution.*

This method, worked out independently by the authors, is essentially the same as that proposed in the meantime by Hall and Bell¹ and later shown by Hall² to be quite suitable for ordinary laboratory use, and their results are fully confirmed by this work. In addition comparative determinations of insoluble phosphoric acid were made, using solutions neutralized by the conductivity method and by the indicator method. The data justified the conclusion that the conductivity method is much to be preferred in every way to the indicator method.

DIVISION OF PHYSICAL AND INORGANIC CHEMISTRY

H. P. TALBOT, *chairman*

S. L. BIGELOW, *secretary*

JAMES R. WITHROW: *The Relative Densities of Sodium Amalgam and Mercury.*

R. B. MOORE: *The Formation of Helium from the Thorium Emanation.*

A. B. DAVIS, IVY MILLER and R. B. MOORE: *Nipponium.*

H. H. WILLARD: *The Quantitative Separation of Lithium from Sodium and Potassium.*

Sodium and potassium may be separated from lithium by precipitation as silicofluoride in methyl alcohol solution. Ethyl alcohol and acetone cause a large amount of lithium to be precipitated with the sodium and potassium. To the solution, which should be very small in volume—not over 10 c.c.—is added a little hydrochloric acid, then hydrofluosilicic acid, and 75 or 80 c.c. methyl alcohol. Several hours are required for complete precipitation. If the amount of lithium is large, the precipitate must be dissolved and reprecipitated. It may be dried at 150°–180°.

Lithium may be quantitatively precipitated from a neutral solution by means of tribasic tetramethyl-ammonium phosphate, methyl alcohol being added to make the precipitation more complete. If present in considerable amount, a little sodium is carried down, but a second precipitation will give a complete separation.

H. H. WILLARD: *The Preparation of Perchloric Acid.*

Ammonium perchlorate is oxidized by means of nitrohydrochloric acid, the ammonium being thus

¹ *Jour. of the Am. Chem. Soc.*, 33, p. 711, 1911.

² *Jour. of Ind. and Eng. Chem.*, 3, p. 559, 1911.

removed and perchloric acid remaining. The best proportions are: 1 kg. ammonium perchlorate, 800 c.c. water, 600 c.c. nitric acid (sp. gr. 1.42), 200 c.c. hydrochloric acid (sp. gr. 1.2). The hydrochloric acid is added slowly to the boiling solution of the other substances, using a reflux condenser. After about one hour the solution is evaporated until all nitric and hydrochloric acid is removed. The yield is the theoretical.

CHARLES H. WHITE: *A Colorimeter for Rapid Work with Widely Varying Standards.*

The standard and the unknown solution are compared in hollow wedge-shaped prisms of glass, placed vertically in a camera behind screens provided with a narrow horizontal opening opposite the eye for the simultaneous observation of the two solutions. The wedges are held in graduated carriers, by the vertical movement of which the thickness of the section of solution observed is varied. The wedge containing the unknown is set at the graduation representing the percentage of color-producing agent in the standard. The standard is then adjusted to match the color of the unknown and the percentage in the unknown is read directly.

IRVING LANGMUIR: *The Dissociation of Hydrogen into Atoms at High Temperatures.*

In a previous paper (to be published in the *Phys. Rev.*) it was shown that the laws of heat convection in gases are much simpler than has been generally supposed. In fact, the problem reduces to one of simple conduction through a film of relatively stationary gas held in place by viscosity. The thickness of the film in any gas under any given conditions may be calculated accurately by simple formulas. If the energy loss for a tungsten filament in hydrogen be calculated in this way the results agree with observed values within the experimental error up to a temperature of about 2300° K., but above this show rapidly increasing differences. At 3300° K. the observed energy loss is over four times the calculated. It is assumed that this difference is due to the dissociation of hydrogen molecules into atoms. The variation of the energy loss with the temperature and with the pressure agree quantitatively with this theory. Simple unforced theoretical considerations form the basis for a calculation of the heat of formation of hydrogen molecules and the percentage dissociation at various temperatures. The results are: Heat of formation of H_2 , 125,000 cal. Percentage dissociation (1 atmo.): at 2500° K. 3.9; 2700°, 10.0; 2900°, 22.1; 3100°, 40.4; 3300°,

61.4. In the case of the monatomic gas, Hg vapor, the calculated energy loss does not show differences with the observed values similar to the above.

IRVING LANGMUIR: *A Chemically Active Modification of Hydrogen.*

When a tungsten wire is heated to a temperature between 1300° and 2500° K. in hydrogen at very low pressure (0.001–0.020 mm.) the hydrogen slowly disappears. With nitrogen or carbon monoxide such disappearance never occurs below about 2200° K. and seems to be an electrical effect, while with hydrogen it is purely thermal. There is a distinct fatigue effect, but the substitution of a new section of wire does not restore the action. The hydrogen is not absorbed by the wire, but is deposited on the glass, especially where the latter is cooled by liquid air. If the wire is allowed to cool and the liquid air is then removed, ordinary hydrogen is set free which will not recondense when the liquid air is replaced. If this gas is pumped out and oxygen is admitted the oxygen will disappear and in its place a small quantity of hydrogen will appear. With platinum and especially with palladium wires these effects are much more marked. These effects are not due to the presence of finely divided metal on the surface of the glass. When phosphorus is present on the inner surface of the bulb and hydrogen is introduced and the wire heated to a temperature of about 1900° K., the hydrogen disappears and phosphine is formed (apparently the first direct synthesis of phosphine). These effects are accounted for by the theory that the hydrogen dissolves in the material of the wire in the atomic condition and that some of these atoms leaving the wire, do not meet other atoms (because of the low pressure) but diffuse into the tube cooled by liquid air, or become adsorbed by the glass, and thus remain in the atomic condition, retaining all of the chemical activity of the atoms.

IRVING LANGMUIR: *Melting Point of Tungsten.*

The melting point was determined by heating pure ductile tungsten wires in pure hydrogen to gradually increasing temperatures until the wire melted through. The temperature was found from the candle power emitted per square mm. of surface, using a modified form of Rasch's equation. The advantages of an atmosphere of hydrogen are: (1) Vaporized metal is carried away by the hydrogen and does not blacken the tube and interfere with candle-power measurements. (2) The energy loss from small wires in hydrogen is nearly independent of the diameter of the wire, therefore

if the wire becomes thin in one spot the tendency to burn out is much less than it would be with the wire run in vacuo. It is therefore possible to make reliable measurements of the candle power at a temperature much closer to the melting point than is possible in vacuo. The results were: in hydrogen 3250° K., 3345°, 3430° and one somewhat doubtful value of 3500°; in mercury vapor, 3450° K. and 3350°. As the method tends to give low results it is highly probable that the melting point of tungsten is at least 3500° K. or about 3250° C. This is in good agreement with the value given by Pirani 3300° C., but very different from that of von Wartenberg, who gave 2900° C.

JOEL H. HILDEBRAND: *The Thermal Dissociation of Barium Peroxide.*

This equilibrium has been investigated on account, not only of its scientific interest, but because of its practical application in the manufacture of oxygen and hydrogen peroxide.

The nature of the phases involved was determined by observing the effect upon pressure of removing successive portions of oxygen, the temperature being kept constant. It was shown that within certain limits the oxide and peroxide form solid solutions in each other, and that a barium hydroxide phase must also be present. Conditions for reversing the equilibrium were stated.

Accurate measurements of the dissociation pressures of the univariant system were made, and the thermodynamics of the system discussed.

S. C. LIND: *Chemical Combination and Disintegration under the Influence of Radium.*

Chemical action produced by radium is due almost entirely to the α -rays. For gas reactions both of combination and of disintegration the number of molecules affected in a given time is of the same order of magnitude as the number of ions formed by the α -rays in that time, as calculated from Bragg's experiment on the ionization of gases. Data of Ramsay and of the author verify this conclusion with respect to radium emanation. A method is proposed for calculating simply the mean path of α -rays in cylindrical and spherical vessels. The principle found true for gases may also be extended to liquid systems, data of Ramsay, of Debierne, and of the author being used for its establishment both for emanation and radium salt in solution.

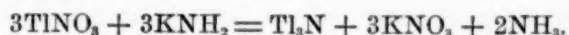
EUGENE C. BINGHAM: *Fluidity and Vapor Pressure.*

E. C. BINGHAM and G. F. WHITE: *Fluidity and Hydration.*

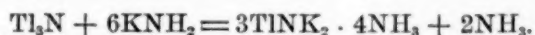
E. C. BINGHAM and G. F. WHITE: *A New Viscosimeter.*

EDWARD C. FRANKLIN: *Potassium Ammono Thallate.*

When the ammonio base, potassium amide, in solution in liquid ammonia is added to a solution of thallium nitrate in the same solvent a black precipitate of thallium nitride is formed in accordance with the equation,



Thallium nitride dissolves in a liquid ammonia solution of potassium amide to a clear yellow solution from which potassium ammonio thallate of the composition represented by the formula, $\text{TiNK}_2 \cdot 4\text{NH}_3$, may be obtained in the form of beautiful yellow crystals. The action of potassium amide on thallium nitride is represented by the equation,



WILLIAM BLUM: *The Hydrolysis of Sodium Oxalate and its Influence upon the Test for Neutrality.*

The testing of sodium oxalate for use as a primary standard in acidimetry and oxidimetry requires a knowledge of the normal alkalinity. Decimolar solutions of pure sodium oxalate were found to produce a pink color with phenolphthalein equivalent to 4 per cent. transformation of the indicator, instead of the calculated 8 per cent., showing discrepancies in the accepted constants or theories. Colorimetric comparisons were made with solutions calculated from Sørensen's E.M.F. measurements, indicating that for 0.1 *m* $\text{Na}_2\text{C}_2\text{O}_4$, $[\text{H}^+]_{18.0} = 2.5 \times 10^{-9}$; and that the salt is hydrolyzed to the extent of 0.0024 per cent. The error produced in a titration by neglecting this normal alkalinity is negligible.

R. C. WELLS: *The Fractional Precipitation of Hydroxides.*

By fractionally precipitating dilute solutions of various pairs of metallic salts with caustic soda the following series was obtained, such that the higher members are more precipitable: ferric, aluminum, copper, zinc, lead, nickel, silver, ferrous, manganese, magnesium, calcium. The position of a metal in the series is probably determined by (1) the solubility of the hydroxide and (2) the extent of hydrolysis of the metallic salt. The series agrees well with the order of the heats of precipitation of the hydroxides.

C. W. EASLEY and B. F. BRANN: *The Atomic Weight of Mercury.*

By means of bringing an excess of pure bromine in contact with pure mercury at approximately 300°, mercuric bromide was sublimed into a convenient receiver, which in turn was heated almost to the point of sublimation of the material in a stream of nitrogen. On cooling, the nitrogen was displaced by dry air.

From this material, mercuric oxide was precipitated by the use of a slight excess over the calculated amount of sodium hydroxide. This action was brought about in a flask with well-guarded openings so that the subsequent reduction with hydrogen peroxide or with hydrazine gave rise to no loss of the solution in the form of spray. The solution being separated from the free mercury, the bromine was determined as silver bromide in the usual way. The value 200.63 was obtained as the result of eleven concordant determinations of the ratio $\text{HgBr}_2:2\text{AgBr}$, no determinations, of course, being rejected.

J. I. D. HINDS: *Precipitation of the Copper-Arsenic Group and the Separation of its Divisions.*

A definite acid concentration is secured. Arsenic is precipitated in 2 normal hydrochloric acid solution, the other metals in half normal hydrochloric acid solution. Tin is precipitated as stannic sulfid. The sulfids of arsenic, antimony and tin are dissolved in colorless ammonium sulfid, or in ammonium hydroxid and hydrogen sulfid.

To a portion of the solution add one ninth its volume of hydrochloric acid (making it normal in HCl since the laboratory acid is about 10 normal) and a few drops of nitric acid to oxidize stannous to stannic ion. Boil the mixture a little more than half away in an Erlenmeyer flask, making the residual liquid 2 normal, pass a rapid stream of hydrogen sulfid until precipitation is complete (5 to 10 minutes), add enough water to make the volume twice the original, making the solution one half normal in hydrochloric acid and continue to pass hydrogen sulfid until precipitation is complete (10 to 15 minutes). Filter and wash.

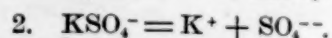
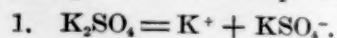
Transfer the precipitate to a beaker, cover it with ammonium hydroxid, pass hydrogen sulfid rapidly for a minute, warm, shake, filter and wash. The filtrate contains the thioanions of arsenic, antimony and tin; the residue contains the sulfids of the other metals of the group.

Treat filtrate and residue in the usual way.

Time required for the entire process 30 to 45 minutes.

WILLIAM D. HARKINS: *The Intermediate Ion Hypothesis.*

The values now used for the degrees of dissociation of univalent salts, such as K_2SO_4 , BaCl_2 or $\text{Cu}(\text{NO}_3)_2$, do not represent the degrees of dissociation at all, but are only the values of the conductance ratio, if intermediate ions are present in the aqueous solutions of salts of this type. In recent papers² it has been shown that the solubility relations of such salts indicate that the ionization takes place in two steps as follows:



Potassium sulphate, according to the present values used, is 71 per cent. dissociated in its tenth normal solution at 25°. Approximate calculations made upon the basis of the intermediate ion hypothesis indicate that its actual *total* dissociation is about 95 per cent.

It seems probable that *all triionic salts, acids and bases, when dissolved in water, dissociate in two steps, and that intermediate ions are present in all such solutions.* If this is the case, it seems self-evident that intermediate ions must be present in *all* aqueous solutions containing salts, acids or bases of still higher types. The percentage of the salt present as the intermediate ion is zero at zero concentration and increases as the concentration of the salt in the solution increases.

The constant $k = (\text{K}^+ \times \text{KSO}_4^- / \text{K}_2\text{SO}_4)$ increases with the total ion concentration and is several times larger, in the case of salts, than the second constant $k = (\text{K}^+ \times \text{SO}_4^{--} / \text{KSO}_4^-)$.

Solutions of certain salts, such as lead chloride, contain an abnormally large percentage of the intermediate ion.

G. R. WHITE and H. EASTWOOD: *Electrolytic Corrosion in Ammonium Salts.*

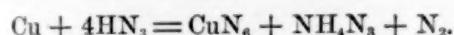
Test pieces of copper, nickel, zinc, tin, iron and cadmium were made anodes in solution of ammonium chloride, sulphate, nitrate, acetate and tartrate containing 75 g. of the salt per liter. The anodes were rotated to ensure thorough stirring. The electrolysis was carried on at room temperature for an hour with a current of .35 amp. The average current density was 2.8 amp. per sq. dm. The results, which are given as percentage efficiency of corrosion, show that corrosion is markedly different for different electrolytes and that it is affected by changing the current density and in some cases by changing the temperature.

J. W. TURRENTINE and RAYMOND L. MOORE: *Contributions to the Electrochemistry of Hydro-*

² *Jour. Am. Chem. Soc.*, 33, pp. 1807-73.

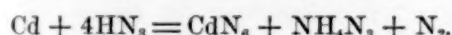
nitric Acid and its Salts. II. The Action of Copper and of Cuprous Oxide on Hydronitric Acid.

In order to test the plausibility of certain reactions proposed to account for the phenomena observed at magnesium, aluminium and zinc anodes in sodium trinitride solution, reactions analogous to those hypothesized were induced and the accompanying phenomena were examined. The action of cuprous oxide on hydronitric acid is that of a reducing agent, the acid being reduced to ammonia and free nitrogen and the cuprous oxide becoming cupric trinitride. The relations here existing may be represented qualitatively by the expression: $\text{Cu}_2\text{O} + 5\text{HN}_3 = 2\text{CuN}_3 + \text{H}_2\text{O} + \text{NH}_3 + \text{N}_2$. With metallic copper, cupric trinitride results, and ammonia and gaseous nitrogen again appear as the reduction products. To represent this reaction, the equation is given:

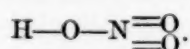


J. W. TURRENTINE and LEONARD A. MAYNARD:
The Reduction of Hydronitric Acid by Cadmium.

Hydronitric acid dissolves cadmium with effervescence. A neutral solution of cadmium trinitride and ammonium trinitride results. The gas evolved is nitrogen. The following equation is proposed to represent the course of the reaction:



The products of the reaction have been measured. In the reactions with cuprous oxide, copper and cadmium (and with numerous other substances), hydronitric acid is found to be an oxidizing agent, an analogue of nitric acid, a fact which leads to an analogous structure. Accordingly, the structural formula for hydronitric acid, $\text{H}-\text{N}=\text{N}=\text{N}$, is proposed, analogous to that of nitric acid,



This structure is supported by numerous reactions and considerations yet to be presented. Just as nitric acid is regarded as a hydrated oxide of nitrogen, hydronitric acid may be considered an ammoniated nitride of nitrogen.

E. H. ARCHIBALD: *The Hydrolysis of Potassium Chloroplatinate.*

The hydrolytic decomposition of solutions of potassium chloroplatinate at a temperature of 25° has been studied. The hydrolysis can be followed by titrating the hydrochloric acid formed with sodium hydroxide, using phenolphthalein as indicator.

The hydrolysis takes place very rapidly under the influence of light, apparently the ultra-violet rays only being concerned, as no action is caused by the strongest illumination from four Welsbach mantles. In bright sunlight at a temperature of 25° the reaction is complete in the case of a *N*/50 solution in 200 minutes when an amount of hydrochloric acid will have been formed equivalent to 36.5 per cent. of the chlorine present as platinum tetrachloride. A solution of this strength prepared in non-actinic light and kept in the dark has not attained equilibrium before several weeks. In the case of a hundredth normal solution the time required for equilibrium to be established in bright sunlight is 175 minutes and hydrochloric acid is formed corresponding to 50 per cent. of the chlorine present as platinum tetrachloride.

The reaction reverses to a small extent when the solution hydrolyzed by the bright sunlight is placed in the dark.

The reaction reverses much further, rapidly in the light but very slowly in the dark, when potassium chloride is added to the hydrolyzed solution.

E. H. ARCHIBALD and E. F. CONWAY: *The Hydrolysis of Potassium Bromoplatinate.*

The hydrolysis of potassium bromoplatinate has been studied after the manner of the previous investigation. The source of the ultra-violet rays was in this case an electric arc placed about 25 cm. from the solution to be studied. The temperature was kept constant at 25°. The hydrolysis is more complete than in the case of the chloroplatinate; the amount of hydrobromic acid formed in a *N*/100 solution corresponded to 78 per cent. of the bromine present as platinum tetrabromide. The reverse reaction also goes further when the hydrolyzed solution is placed in the dark.

A solution of the bromoplatinate prepared in the absence of actinic rays and kept in the dark showed no detectable hydrolysis after five days.

H. C. COOPER, E. H. KRAUS and A. A. KLEIN:
Lead Silicates.

Having subjected the system $\text{PbO}-\text{SiO}_2$ to thermal analysis and optical analysis, the latter particularly difficult because the refractive indices of most of the lead compounds are higher than the index of any known immersion liquid, the authors conclude that PbSiO_3 , Pb_2SiO_4 and $\text{Pb}_3\text{Si}_2\text{O}_7$ are well-defined compounds and that $\text{Pb}_3\text{Si}_2\text{O}_7$ is probably also an independent substance. The minerals barysilite, found in Sweden by Sjögren and Lundstrom and the mineral alamosite, recently described independently by Palache, correspond fully

with the compounds $\text{Pb}_3\text{Si}_2\text{O}_7$ and PbSiO_3 , respectively. It is interesting that the artificial alamosite was prepared and characterized before its counterpart was found in nature. The crystallized lead silicate formations found under dismantled smelters are rather miscellaneous in character, the largest crystals being of mixed composition.

H. S. FRY: *Some Application of the Electronic Conception of Positive and Negative Valencies: V. Dynamic Formulæ and Absorption Spectra of Chlor- and Brom-benzenes.*

F. D. WILSON: *A Further Study of the Action of Calcium Carbonate on Zinc Sulphate Solutions.*

When calcium carbonate and zinc sulphate solutions are brought into contact with one another in varying preparations, and at different temperatures, and for different periods of time, the basic carbonate is formed.

When the solution of zinc sulphate is changed into carbon dioxide, and calcium carbonate added, and carbon dioxide passed in for several days, the normal carbonate of zinc with from 0.8 to 1.5 per cent. of water is formed.

ROBERT B. SOSMAN: *The Nitrogen Scale from 300 to 600 Degrees.*

CHARLES BASKERVILLE and ABRAHAM LUSSKIN: *Chemical Tests for Lanthanum.*

As far as we are aware, there are no chemical tests for lanthanum which are so distinctly characteristic as to be used to prove the presence of that element when associated in mixtures with neodymium or praseodymium. Recourse must be had to photographic reproduction of the arc or spark spectrum, facilities for which do not constitute a part of the armamentarium of all analytical chemists, and at best this is not applicable upon a quantitatively qualitative basis.

Having exhausted the probabilities of analogous tests for other metals, recourse was had to the empiricism offered by a Kahlbaum catalogue. While much not recorded in the literature was observed as to the conduct of this subgroup of the so-called rare earths with many unusual reagents, the main object was to secure some one or more definitely distinctive tests for lanthanum alone or in mixtures. While it may be stated that results altogether satisfactory were not obtained, the following may be noted.

Conduct with Sodium Potassium Tartrate.—Solutions of lanthanum, neodymium and praseodymium salts, singly or mixed with each other,

give precipitates with this reagent which dissolve in an excess of the precipitant. On adding oxalic acid to these solutions a precipitate is produced in each case, but with lanthanum the precipitate is soluble in excess. Filtration, evaporation and ignition yield lanthanum oxide. The delicacy of the reaction and all the determining factors have not been established.

Conduct with Cyanates.—Potassium cyanate gives a white gelatinous precipitate insoluble in excess. On standing the precipitate changes into beautiful silk-white crystals. Similar conduct was observed with neodymium and praseodymium salts, except that each of the latter exhibited the characteristic rose or light green tint. The solubility of these cyanates, the composition of which has not been determined, was investigated, using a great variety of solvents, some very unusual. A difference was noted in the solubility in bromine water, the lanthanum salt being more soluble. In acetic acid, however, the lanthanum salt dissolved much more slowly. The same was noted with lactic and phthalic acids and boiling sodium tartrate solutions. In the last the neodymium preparation is entirely soluble, whereas the lanthanum salt is only slightly, but appreciably, soluble.

Neither of the methods has so far shown itself suitable either for satisfactory qualitative purposes or for separating lanthanum from the didymium on a laboratory scale.

Suggestions as to rarely applied tests will be most acceptable.

CHARLES BASKERVILLE: *On the Simplicity of Praseodymium.*

The results of twelve years' study of praseodymium with different assisting workers in an effort to show its complexity are given. All efforts to decompose praseodymium were unsuccessful. The investigations were carried out along the following lines: (1) fractional precipitation from salt solutions; (2) fractional solution of the black oxide in acids; (3) fractional decomposition of the nitrate by heat; (4) fractional crystallization of double nitrates, one being an isomorphous nitrate of another metal; (5) fractional oxidation of a soluble salt of praseodymium; (6) fractional oxidation of the oxide by fusion with an alkali peroxide, and (7) fractional electrolysis, with and without a porous cell. The absorption spectrum of the different fractions, several thousand all told, was taken as a criterion as to any disintegration. Solutions of a definite strength, acidity and thickness were compared.

J. E. MILLS: *Force.*

Elasticity is a property very similar to temperature, depending upon the motion of certain parts of larger elastic bodies. When these fundamental particles collide they simply exchange velocities instantaneously. Neither motion nor energy is for a fraction of a second lost.

The usual definition of force is: "A unit force is that force which, acting on a mass of one gram for one second, will give to it a velocity of one centimeter per second." In a medium when the particles exchange their velocities instantaneously this definition of force does not apply, as the words "for one second" have no meaning. More important is the fact that the kinetic energy of a moving body must then be measured by its mass (probably amount of matter) times its velocity, instead of by one half its mass times the square of its velocity.

The term "attractive force" has been applied to chemical, molecular, gravitational, electrical and magnetic attractions. Some in consequence of our definition of force have invested these phenomena with attributes which they do not possess.

W. E. HENDERSON: *A Jacket for a Victor Meyer Apparatus.*

The usual form of glass jacket is replaced by a beaker deep enough to contain the bulb of the inner tube. The beaker is covered with a copper sheet in the center of which is a circular hole large enough for the insertion of the bulb. Concentric with this hole is a deep groove in the cover in which the square end of a piece of large glass tubing rests in a water seal (a broken outer jacket cut square will serve). The beaker should have no lip.

W. E. HENDERSON and H. B. WEISER: *The Action of Sulphurous Acid upon the Sulphides of Iron and Manganese.*

When freshly prepared sulphides of iron or manganese are treated with sulphurous acid the primary action appears to be the production of the metallic sulphites and hydrosulphuric acid. The sulphites are held in solution as acid salts, and are precipitated as normal salts on warming the solution. The interaction of sulphur dioxide and hydrosulphuric acid produces free sulphur which converts a portion of the sulphites into thiosulphates. These have been isolated in pure form. Contrary to the statements in the literature, there is no dithionate or tetrathionate formed beyond possibly a mere trace.

R. F. BRUNEL: *The Equilibrium between Iso and Tertiary Butyl Bromides.*

CHAS. T. P. FENNEL: *A Strange Substance in Iodine.*

A. S. MCDANIEL: *Chemistry of the Silver Voltameter.*

CHAS. A. KRAUS and WM. C. BRAY: *A General Law of Ionization of Binary Electrolytes.* (Presented by Wm. C. Bray.)

From a preliminary examination of the existing conductance data in various solvents the first named author four years ago suggested the relation

$$\frac{(C\gamma)^2}{C(1-\gamma)} = K + D(C\gamma)^m,$$

where C is the concentration, γ the degree of ionization calculated from the conductance ratio Λ/Λ_0 , and K , D , m are constants. A more careful study, which is still in progress, has furnished striking confirmations of this law. The evidence that the law of mass action is obeyed in dilute solutions is based on the experimental results of Franklin and Kraus in liquid ammonia and of Dutoit and his coworkers in propyl, butyl and amylalcohols and in acetone, sulfur dioxide, pyridine, etc. There is a rough parallelism between the values of K for a typical salt (as NaI) and the dielectric constants of the pure solvents. The deviations from the law of mass action are in general appreciable when the ion concentration is greater than 0.0005 normal. The values of m usually lie between 0.4 and 0.6 in aqueous solution and between 0.9 and 1.2 in liquid ammonia and are still larger in solvents of lower dielectric constants. Whenever m is greater than 1, the values of the equivalent conductance pass through a minimum as the concentration increases and then increase with increasing concentration. D is the controlling factor in determining γ at high ion concentration, and usually lies between 0.1 and 5.0 for the different solvents. The above law ceases to hold in the neighborhood of normal concentration, and Λ then decreases with increasing concentration. There is evidence that this decrease is connected with the rapidly increasing viscosity of these concentrated solutions.

HARRY N. HOLMES: *The Detection of Ozone.*

The paper presented the various theories explaining the presence of ozone in nature and gave the results of six months' ozone tests in outdoor air. In June and July the quickest response to a starch potassium-iodide test was an hour and a

quarter, except in the case of a thunder-storm, when the record was set at fifteen minutes. In the hottest days of July no test at all could be obtained and none at night in either month. This would seem to indicate that the ultra-violet rays of sunlight have a great deal to do with the formation of ozone.

In the bracing days of late November the weather was cold and snappy. A test resulted in less than twenty-five minutes on November 13. During the following three weeks several tests were secured in thirty or forty minutes. At this time the silent electric discharge between earth and clouds must have been quite instrumental in forming the ozone. The greater stability of ozone in cold weather allowed it to accumulate.

Probably after a cyclonic disturbance of the upper air we on the surface get a supply of ozone manufactured in the upper laboratories. On the occasion of some of the above tests air was drawn over crystals of chromic acid to eliminate the effect of hydrogen peroxide. Furthermore, delicate reagents for hydrogen peroxide and nitrites failed to yield a test. The inference is that all the above tests were due to ozone alone.

JAMES M. BELL and MELVILLE L. BUCKLEY: *The Solubility of Bromine and Iodine in Aqueous Solutions of Alkali Bromides and Iodides.*

C. W. FOULK: *A Modified Burette Calibrating Pipette.*

W. M. BLANCHARD: *A Simple Lecture Apparatus for Illustrating the Relative Ionizations of Salts.*

ARTHUR B. LAMB and JOHN W. MARDEN: *The Quantitative Determination of Perchlorates.*

The determination of perchlorates by fusion has, in spite of its great simplicity, been generally abandoned in favor of some method of reduction in solution. This has been due to the fact that during ignition or fusion there have been small but apparently unavoidable mechanical losses, presumably of potassium chloride. The authors have shown that by merely carrying on the fusion in a test tube, suitably plugged with asbestos wool, instead of in a crucible, these losses could be prevented, and by precipitation of the chloride as silver chloride a very simple but accurate determination of the perchlorate obtained.

G. N. LEWIS and F. G. KEYES: *The Potential of the Potassium Electrode.*

G. N. LEWIS and PAUL FARRAGHER: *Potentials between Liquids.*

J. E. SIEBEL: *The Molecular and Intermolecular Energy.*

In this paper the author attempts to show that, " PxV " being practically equal to " RxT " for permanent gases, no notable portion of the kinetic energy can be present therein as rotary or intermolecular motion, since neither of these motions could contribute to the pressure and volume energy, of which a full equivalent appears for every amount of heat or kinetic energy imparted to a gas, and that therefore all kinetic or heat energy of gases must be almost exclusively due to the translatory motions of the molecules, while other internal molecular motions must be confined to chemical, radiant and other energies. Confirmatory of this the author also finds that the translatory molecular velocity in gases calculated on above basis, after different independent methods, is uniformly almost exactly double that of the velocity of sound in the respective gases, thereby indicating another mode of propagation of sound in addition to that by aerial resonance, in which new mode of propagation the molecular vibrations act as vehicle for the sound impulses, which new mode of propagation would fully explain all acoustic phenomena, including also such (audibility of very feeble sounds for miles, etc.) not explainable by aerial resonance only.

A. A. NOYES: *A Proposed System of Notation of Physico-chemical Quantities.*

JOHN JOHNSTON: *A New Form of Mechanical Vacuum Pump.*

This pump—known as the May Nelson Rotary Pump—consists essentially of two plates of metal, one fixed, the other movable; no valve, packing or fluid is required, though a little lubrication is desirable for mechanical reasons. A somewhat defective pump of this type has given a vacuum of 0.01 mm. when connected to the gauge by rubber tubing. It has exhausted 6 liters to 0.1 mm. in 2 minutes. After pouring in 1 c.c. of water, the pressure was reduced to 0.5 mm. in 4 minutes, without drawing any air through the pump. The exact mode of working is difficult to show without a diagram, but the principle may perhaps be made sufficiently clear by what follows:

In each of the metal plates are cut a series of concentric grooves, which are so situated that the projections on each plate will lie in the grooves on the other plate. Through the center of the fixed plate passes a shaft, on which is an eccentric carrying the movable plate. Rotation of the shaft thus produces an eccentric motion—but no rotation—of the movable plate; as a result there is,

between each adjacent pair of curved surfaces, a rolling contact which sweeps out the air ahead of it. The pump above mentioned has an inner diameter of 13 cm., a depth of 4 cm., and consists of three rings which pump in series; the speed of rotation of the shaft was 800 r. per minute; $\frac{1}{4}$ H.P. suffices to operate it.

The effectiveness of this form of pump appears to be due to two things: (1) A very slight travel of the metal parts produces a relatively rapid motion of the crescent-shaped spaces between the rings on the two plates; (2) the contacts, since they occur between curved surfaces of nearly the same radius, are relatively long; hence the viscosity of the air is sufficient to prevent appreciable leakage backwards.

This pump may also be operated as a blower, or, with slight modifications, can be used as a water motor; indeed, since the rings may be made independent of one another, one can drive the pump by supplying water to one ring and obtain vacuum or blast from the other rings.

SECTION OF INDIA RUBBER CHEMISTRY

D. A. Cutler, *chairman*

F. J. Maywald, *secretary*

W. A. DUCCA: *Testing Methods of Rubber Contents in Raw and Vulcanized Rubber.*

The paper deals with modern methods of rubber analysis by nitrosate and tetrabromide methods. Mostly a historical review of the work done along these lines. In accordance with his own experiences the author concludes that the nitrosate method is not suitable for the determination of rubber in either raw or vulcanized samples, but yields apparently satisfactory results for sulfur of vulcanization. Budde's tetrabromide method gives a fair idea of the percentage of actual rubber in samples of raw material, but is not applicable for vulcanized goods. Huebner's method, bromination under water, based on the Weber-Ditmar theory of vulcanization, is very unreliable in its present form. Until now only a way has been opened towards the development of methods to determine rubber directly.

S. P. THACHER: *On Mineral Compounds Used in Rubber.*

VICTOR HANZLIK: *A Few Notes on Rubber Goods Used in Beet Sugar Factories.*

FRANCIS R. PEABODY: *The Treatment of Crude Rubbers.*

DAVID BLOOM: *Does the Acidity of Crude Rubber Resin Indicate Its Botanical Origin?*

Rubber resins obtained by extraction with acetone, carefully dried and redissolved in warm alcohol, were titrated with standard alkali. The acidity of the resin (expressed as the number of cubic centimeters of alkali used) is referred to a standard quantity of the resin (one hundred milligrams) and this ratio is called the "acidity number."

In the course of the analyses of about one hundred and fifty varied samples of washed and unwashed crude rubbers, the acidity numbers of the resins seem to be a constant for all rubbers of the same class, regardless of their age or mechanical treatment.

CHARLES FOX: *Apocynum Rubber.*

CHARLES KNIGHT (chairman): *Report of Committee on Rubber Analysis.*

CHARLES L. PARSONS,
Secretary

SOCIETIES AND ACADEMIES

THE CHICAGO SECTION OF THE AMERICAN MATHEMATICAL SOCIETY

THE twenty-ninth regular meeting of the Chicago Section of the American Mathematical Society was held at the University of Chicago on Friday and Saturday, December 29-30, 1911, extending through three half-day sessions. The total attendance was fifty-seven, including forty-three members of the society.

Professor L. E. Dickson, chairman of the section, presided at the opening session on Friday morning. Professor E. B. Van Vleck presided at the session on Friday afternoon while Professor Dickson was delivering his address on the "History of the representation of numbers as the sum of squares," and Professor E. J. Townsend presided at the session on Saturday morning.

At the business meeting on Saturday morning the following officers of the section for the year 1912 were elected: Professor D. R. Curtiss, chairman; H. E. Slaught, secretary, and A. L. Underhill, third member of the program committee.

On Friday noon the members lunched together at the Quadrangle Club, and in the evening they dined together at the same place and spent one of the most enjoyable social occasions in the history of the section.

The following papers were read at this meeting:

Professor Arnold Emch: "Involutoric circular transformations as a particular case of the Steinerian transformation and their invariant net of cubics."

Dr. R. E. Root: "Iterated limits in general analysis."

Dr. Arnold Dresden: "Reduction of systems of linear differential equations of any order."

Dr. Louis Ingold: "Displacements in a function space."

Professor L. E. Dickson: "History of the representation of numbers as the sum of squares."

Professor F. R. Moulton: "Relations of families of periodic orbits in the restricted problem of three bodies."

Professor L. E. Dickson: "Note on Waring's theorem."

Professor L. E. Dickson: "Uniqueness of division in Cayley's algebras with eight units."

Professor J. B. Shaw: "On differential invariants."

Professor E. J. Wilczynski: "On some geometric questions connected with the problem of three bodies."

Professor Peter Field: "On Coulomb's laws of friction."

Dr. E. G. Bill: "Analytic curves in non-euclidean space."

Mr. H. F. Vandiver: "Theory of finite algebras."

Dr. Arnold Dresden: "Note on the second variation; Jacobi's equation and Jacobi's theorem in the calculus of variations."

Professor G. A. Miller: "Gauss's lemma and some related group theory."

Professor R. D. Carmichael: "On a class of linear functional equations."

Professor R. D. Carmichael: "On the theory of the gamma function."

Mr. Vandiver's paper was communicated to the society through Professor Dickson. In the absence of the authors, the papers of Mr. Vandiver, Dr. Bill, Professor Miller and Professor Carmichael were read by title.

The next meeting of the Chicago Section will be held at the University of Chicago, on Friday and Saturday, April 5 and 6, 1912.

H. E. SLAUGHT,
Secretary of the Section

THE BOTANICAL SOCIETY OF WASHINGTON

THE 78th regular meeting of the society was held at the Cosmos Club, Tuesday, February 6, 1912, at 8:00 P.M. President W. A. Orton presided. Thirty-seven members were present. Dr. H. W. Wollenweber and W. W. Ashe were elected to membership.

The following papers were read:

Conditions Favorable to Septoria lycopersici Speg.:
J. B. S. NORTON.

The author reported on a series of observations made on the development of *Septoria* under various conditions affecting growth.

The Relation of Soil Acidity to Plant Societies:
A. W. SAMPSON.

Since the day of Unger and Thurmann there has been considerable difference of opinion as to the relationship between soil chemistry and cover. The fact, however, that different soils support different plants is a matter of common observation. The bearing of soil acidity upon this point has been investigated by the author—chiefly in connection with range revegetation studies conducted in the Wallowa Mountains of northeastern Oregon.

The *Leguminosae* are commonly extremely sensitive to acid soils while many ericaceous species are rather closely confined to acid soils. For example, *Trifolium repens* fails in soils requiring for neutralization the relatively small amount, locally, of 5,000 pounds of lime per acre foot, while no species of *Vaccinium* is known that can be grown successfully in neutral or alkaline soils. Again, some genera (*e. g.*, *Populus* and *Rosa*) are apparently indifferent as regards soil preferences. The preeminent forage plant of the Wallowa Mountains, *Festuca viridula*, varies very widely in adaptability to acidity. The soils on which it grows luxuriantly vary in lime requirements from 5,000 to 41,000 pounds per acre foot. The four species of *Poa* and the two species of *Agropyron* occurring locally reach their best development on calcareous and neutral soils.

Notes of Travel in Central America: Professor A. S. HITCHCOCK.

Having visited the Canal Zone as members of the Smithsonian Biological Survey, Mr. Hitchcock and his son made a two months' side trip to Central America. Collections were made in Costa Rica at Port Limon, San José and Puntarenas, in Nicaragua at San Juan del Sur, Corinto, Masaya and Jinotepe, in Honduras at Amapala, in Salvador at La Union, Acajutla, Santa Ana and San Salvador, in Guatemala at Guatemala City, Volcanso Agua and Port Barrios. Mr. Hitchcock presented notes on the various incidents connected with travel in the countries mentioned and reviewed briefly the botanical results of the journey.

W. W. STOCKBERGER,
Corresponding Secretary